

INTEL 12th GEN & DDR5: WHAT TO EXPECT

apoc

SINCE 1980

NOVEMBER 2021 #499

YOUR EXPERT GUIDE TO TODAY'S TECH



RETROTECH
THE FIRST APPLE MAC

+ HOW TO EMULATE
IT ON YOUR PC

**ADOBE
ILLUSTRATOR
vs AFFINITY
DESIGNER**
CAN THE CHEAPER
NEWBIE BEAT ADOBE?

**LITTLE
WONDER**
DIY ITX PC:
SMALL YET
MIGHTY

SECURE YOUR PC

2021

ANTI-VIRUS SUPERGUIDE

FREE AND PAID VERSIONS COMPARED * SHOCK WINNER!

UTURE
L
F
\$10.95 INC GST N2 \$10.90 INC GST
T POST APPROVED: 100000179
0725-4415

9 313006 1001362

Computer Killer

HOW THE WORLD'S
TECH COULD BE
WIPED OUT IN
AN INSTANT

**UNLEASH YOUR
MUSICAL TALENT**
PERFORM LIVE WITH YOUR MAC

**PI PROJECTS:
6 OF THE BEST**

**DO A FRESH
WIN 11 INSTALL**

NBN SMB Solutions for VDSL2 35b & Ethernet WAN (FTTN/B, FTTP, HFC, Fixed Wireless, Satellite)

DrayTek
Aust & NZ
www.draytek.com.au



Vigor2865 Series

Multi-WAN VDSL2 35b/ADSL2+ router with 1 x configurable GbE WAN/LAN port, 5 x GbE LAN ports, SPI Firewall, 802.11ax/ac Wi-Fi, VoIP and 32 x VPN tunnels including 16 x SSL-VPN tunnels



Vigor2865ax (AX3000)



- Multi-WAN with 1 x VDSL2 35b Supervectoring/ADSL2+ WAN port, 1 x configurable GbE WAN/LAN port, 2 x USB ports and 2 x Wi-Fi WANs (ax/ac/Vac models)
- 1 x XDSL port and 1 x configurable GbE WAN/LAN port for Failover, Load Balancing and High Availability mode
- 2 x USB 2.0 ports for 3G/4G LTE USB modems, FTP server, network printer or thermometer
- 5 x Gigabit LAN ports with multiple subnets and 60,000 NAT sessions
- 32 x VPN tunnels (including 16 x OpenVPN/SSL-VPN tunnels) with most security protocols
- Fast VPN throughput, VPN load-balancing and backup for site-to-site applications
- 16 x VLANs for secure and efficient workgroup management

- IPv6 & IPv4; Up to 1022 IP addresses and 8 IP subnets
- Integrated IEEE 802.11ax/ac wireless Access Point; dual band; up to 3000 (ax) or 867 (ac/Vac) Mbps throughput
- Object-based SPI Firewall and CSM (Content Security Management) for network security
- VoIP (2 x FXS ports) for Vigor2865Vac
- Support VigorACS 2 and VigorACS 3 Central Management Systems for remote management
- SD WAN capability when used with VigorACS 3
- Central VPN Management for up to 8 remote Vigor routers
- Central AP Management for up to 20 Vigor Access Points
- Central Switch Management for up to 10 VigorSwitches
- 2 years back to base warranty

Vigor2765 Series

VDSL2 35b/ADSL2+ routers with 1 x configurable GbE WAN/LAN port, 3 x GbE LAN ports, SPI Firewall, 802.11ac Wi-Fi, and 2 x VPN tunnels including 2 x SSL-VPN



Vigor2765Vac



- 1 x VDSL2 35b/ADSL2+ WAN port
- 35b Supervectoring VDSL2
- 1 x configurable GbE WAN/LAN port (P4)
- 3 x Gigabit Ethernet LAN ports with 50,000 NAT sessions
- 2 x USB ports for 3G/4G LTE mobile broadband access, USB printer and storage
- Object-based SPI Firewall, CSM (Content Security Management) and QoS for network security
- IPv6 & IPv4
- 2 x VPN tunnels including 2 x SSL-VPN tunnels
- IPsec VPN throughput at 200 Mbps (AES 256 bits)

- Integrated IEEE 802.11ac wireless Access Point (Vac/ac model)
- 2 x FXS VoIP (Vac model)
- Support VigorACS 2 and VigorACS 3 Central Management Systems for remote management
- Central AP Management for up to 2 Vigor Access Points
- 2 years back to base warranty

Vigor130

VDSL2/ADSL2+ modem/router with 1 x GbE LAN port and SPI Firewall



- 1 x VDSL2/ADSL2+ WAN port
- 1 x Gigabit Ethernet LAN port
- VDSL2 vectoring
- Bridging for VDSL2 and ADSL2+
- Object-oriented SPI Firewall
- IPv6 & IPv4
- Support VigorACS 2 and VigorACS 3 Central Management Systems for remote management
- 1 years back to base warranty



i-LAN Technology Pty Ltd trading as DrayTek Aust & NZ



www.i-lan.com.au



(02) 9838 8899



sales@i-lan.com.au

© Copyright 2021 i-LAN Technology Pty Ltd. All rights reserved.



SUBSCRIPTION ENQUIRIES

(02) 8227 6486
www.techmags.com.au
future@crmaus.com.au

Editorial

Editor: **Ben Mansill** ben.mansill@futurenet.com
Senior Journalist: **Shaun Prescott**
Journalist: **Joel Burgess**
Journalist: **Harry Domanski**
Journalist: **Stephen Lambrechts**
Journalist: **Sharmisha Sarkar**
Creative Director: **Troy Coleman**

Contributors

Jonni Bidwell, Matt Castle, Alan Dexter, Andrew E. Freedman, Christian Guyton, John Knight, Rowan Kaiser, Aaron Klotz, Aleksandar Kostovic, Jeremy Laird, Sam Lewis, Chris Livingston, David Lumb, Jody Macgregor, Carrie Marshall, Steven Messner, Francisco Pires, Les Pounder, Aris Mpitziopoulos, Mayank Sharma, Shashank Sharma, Anton Shilov, Zak Storey, Tom Sykes, Chris Szevczyk, Mark Williams, Darren Yates

Photography

All copyrights and trademarks are recognised and respected

Advertising

auadvertising@futurenet.com

Management

Managing Director: **Neville Daniels**
Sales Director: **Paul Marttila** paul.marttila@futurenet.com

Printed in Australia by IVE

Distributed in Australia and NZ by Ovato
ovato.com.au

ISSN 0725-4415

Future Publishing Australia

PO Box Q1179, Queen Victoria Building, NSW 1230

Corporate Web: www.futureplc.com

Email: apcmag@futurenet.com

We are committed to only using magazine paper which is derived from responsibly managed, certified forestry and chlorine-free manufacture. The paper in this magazine was sourced and produced from sustainable managed forests, conforming to strict environmental and socioeconomic standards. The manufacturing paper mill holds full FSC (Forest Stewardship Council) or PEFC certification and accreditation

All contents © 2018 Future Publishing Australia or published under licence. All rights reserved. No part of this magazine may be used, stored, transmitted or reproduced in any way without the prior written permission of the publisher. Future Publishing Limited (company number 2008685) is registered in England and Wales. Registered office: Quay House, The Ambury, Bath BA1 1UA. All information contained in this publication is for information only and is, as far as we are aware, correct at the time of going to press. Future cannot accept any responsibility for errors or inaccuracies in such information. You are advised to contact manufacturers and retailers directly with regard to the price of products/services referred to in this publication. Apps and websites mentioned in this publication are not under our control. We are not responsible for their contents or any other changes or updates to them. This magazine is fully independent and not affiliated in any way with the companies mentioned herein.

If you submit material to us, you warrant that you own the material and/or have the necessary rights/permissions to supply the material and you automatically grant Future and its licensees a licence to publish your submission in whole or in part in any/all issues and/or editions of publications, in any format published worldwide and on associated websites, social media channels and associated products. Any material you submit is sent at your own risk and, although every care is taken, neither Future nor its employees, agents, subcontractors or licensees shall be liable for loss or damage. We assume all unsolicited material is for publication unless otherwise stated, and reserve the right to edit, amend, adapt all submissions.

Privacy statement

If you provide information about yourself this will be used to provide you with products or services you have requested. We may supply your information to contractors to enable us to do this. Future Publishing Australia will also use your information to inform you of other publications, products, services and events. Future Publishing Australia may also give your information to organisations that are providing special prizes or offers and are clearly associated with the Reader Offer. Unless you tell us not to, Future Publishing Australia may give your information to other organisations that may use it to inform you of other products, services or events. If you would like to gain access to the information Future Publishing Australia holds about you, please contact us.



Future plc is a public company quoted on the London Stock Exchange (symbol: FUTR)
www.futureplc.com

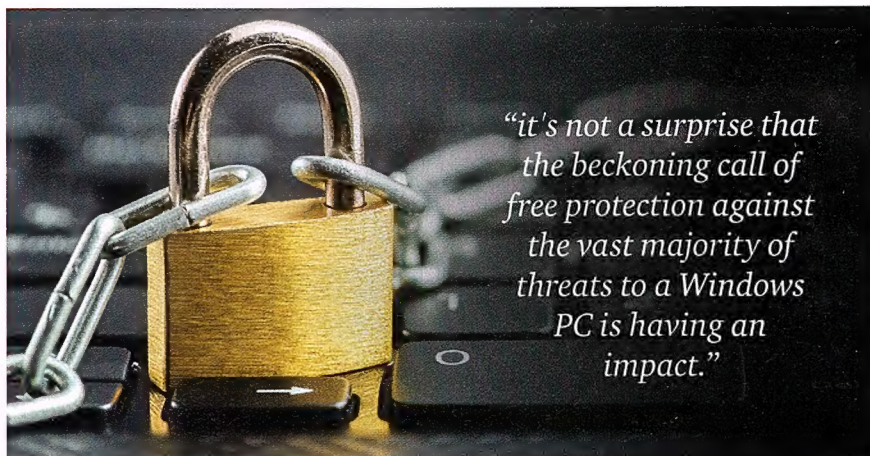
Chief executive **Zillah Byng-Thorne**
Non-executive chairman **Richard Huntingford**
Chief financial officer **Penny Ladkin-Brand**

Tel +44 (0)1225 442 244

INTRO

EDITORIAL

FOUR HUNDRED AND NINETY NINE.



"it's not a surprise that the beckoning call of free protection against the vast majority of threats to a Windows PC is having an impact."

© Shutterstock

EDITORIAL

Protection

Back to basics.



BEN MANSILL

Ben's been editing tech mags since 1994, and hasn't had a haircut since lockdown started so doesn't look much like the picture above any more.

Well well, Windows Defender turns out to be all most people need. From being the much-maligned unwanted child of the security industry, to now offering system security equal or better than the paid options.

Talk about disruptive! This nullifies the main selling point of the popular security suites, and it's been heading in that direction for a while. They all saw the writing on the wall, and a security suite today offers much more than simple AV and malware protection. That's why they're called suites, and is also why the term 'anti-virus' has been pushed out of the marketing and branding message progressively over the years.

Yep – the threat landscape is indeed complex and we've seen some really effective tools added in the last few years, like identity protection, anti-malware and secure browsers for banking and whatever else you want to do in untraceable privacy. On that front too, it's rare to find a suite today without a VPN service built in. Some charge extra for that, others recognise that, really, to win over customers and not appear absolutely mercenary in their pricing these extras are bundled into the standard package.

There's a lot of people, though, that just don't need those facilities, and with the increasing sensitivity about subscription-based pricing, it's not a surprise that the beckoning call of free protection against the vast majority of threats to a Windows PC is having an impact on whether or not people choose to add yet another sub to the list. Security suites were among the very first to introduce the subscription model so there's a large base of customers familiar with that annual ~\$100 routine – but probably too, a large group keen to sever ties with a long-standing cost like this.

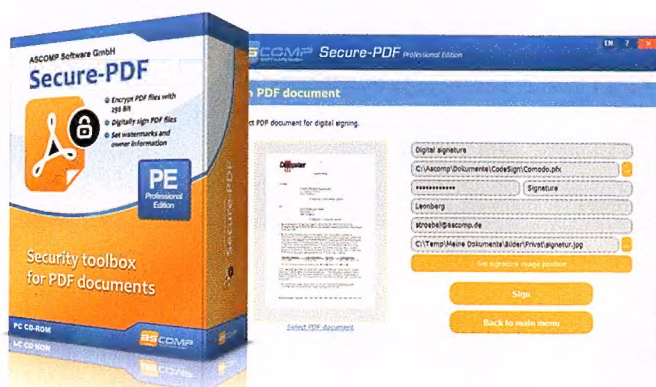
I'm not sledging the security business, or suggesting everyone abandon what they use in favour of Defender – as APC readers you know what you need, and very likely serve to give guidance to friends and family that rely on your knowledge and experience. I personally use Norton, have for at least a decade. It plays nice with my gaming and never gets in the way, and the VPN is handy on occasion. But I don't ever fret over AV nasties getting in and wrecking my PC, and for a couple of connected PCs I run at home that I've built in the last few months I now don't even bother installing it. One is my sim racing PC that only ever connects to a game server and rarely even sees a browser fired up. That's the sort of case where Defender is a winner, and free.

Good job, Microsoft, congratulations are deserved for sticking with it and making this a top shelf performer.

BEN MANSILL

Exclusive downloads

Your free full-version apps as a thanks for reading APC. These exclusive downloads will only be available for a limited time, from 04/10/21 to 21/11/21.



SECURE-PDF

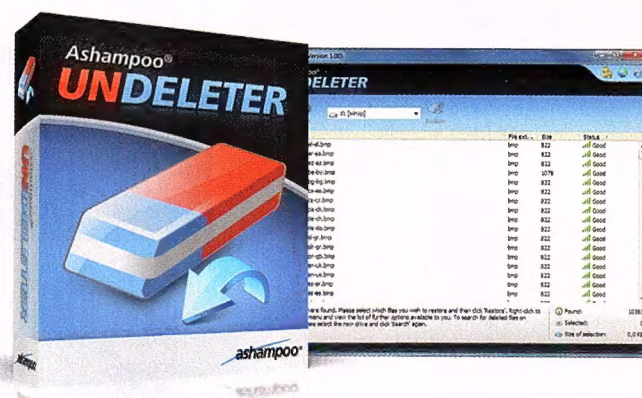
Security toolbox for PDF files including encryption and signing.

The PDF format is used worldwide to distribute graphically processed documents. However, editing the documents is usually associated with high costs because good PDF editors are quite expensive. The cheaper alternatives on the other hand, lack the important functions to make PDFs secure, for example by encrypting, digitally signing or adding watermarks.

Secure-PDF puts an end to this: Encrypt your own or other people's PDF documents with up to 256 bit key strength (AES). Add a password to open it so that users can only view the encrypted document by entering the correct password.

Secure-PDF can set watermarks as well as the owner information of a PDF document – even without previous knowledge of how to use PDF documents!

Download link: www.apcmag.com/exclusives



ASHAMPOO UNDELETER

Never again trouble with accidentally deleted files.

In our daily lives with computers small and big disasters can always happen. It is very annoying, if for example a beautiful picture, an important document or favourite MP3 is lost or accidentally deleted.

In such a situation Ashampoo Undeleter is your salvation. With this program deleted files are recovered in next to no time.

So, if you accidentally deleted your favourite song from your PC, this isn't a disaster any more. Just use the effective search function of the Ashampoo Undeleter and have the program generate a list with all deleted files. In such a list even the condition of the files is displayed. This shows whether the files can be recovered completely, partly, or not at all. Then you can recover your favourite song in your desired location with just one click.

Download link: www.apcmag.com/exclusives

ASHAMPOO BACKUP PRO 14

Whether ransom ware, system flaw or defect hardware – a backup will help!

Experience maximum safety with Ashampoo Backup Pro 14! Because this backup software constantly checks itself and even the storage medium upon which the backups are stored. Due to the automatic verification, backup mistakes are practically ruled out! The new backup engine has been tested and checked severely and optimised in intensive cooperation with the support service and numerous clients. The internet backup by cloud services has been widely re-programmed – to your personal advantage! It has never been so easy, simple and performant to backup into the cloud! Exploit the most



secure, most compatible and most comfortable Ashampoo Backup of all times!

Download link: www.apcmag.com/exclusives

DISCLAIMER Future Publishing is not the licensor of the exclusive software or any documentation included with it. Rather, Future is merely a distributor of the software, and your use of the software is subject to any accompanying third-party licence terms. You must carefully read and comply with any such third-party licence terms, together with all instructions and README files that come with the software. Accordingly, to the maximum extent permitted by law, all software is provided by Future 'as is' and without warranty either express or implied, and Future will not be liable for any damage that you may incur as a result of using any software downloads. You should back up any important system and data files before using any downloaded software. We recommend that you do not use the exclusive software on a production machine. Nothing in this disclaimer excludes any warranty that may be implied by statute, which may include the Trade Practices Act. While we have taken all reasonable steps to check the software downloads for viruses, we cannot guarantee that it is free from viruses or other harmful code and you should check each download using a virus scanner complete with the latest antivirus updates before use.

ASUS

00000000



TUF-AX5400 GAMING ROUTER

Wired Performance for WiFi

RELIABLE PERFORMANCE

2X faster WiFi speed up to 5400Mbps
80% wider coverage with OFDMA technology
Improved stability with special thermal design

ONE ROUTER. ALL GAME TYPES

Gaming Port to prioritize game devices
Open NAT for 3 steps easy port forwarding
Mobile game mode for optimized experience

SWITCH MODES FOR EASY LIFE

Work from Home mode
Learn from Home mode
Media & Gaming modes

WiFi 6



TUF GAMING

PAGE 50

SECURE YOUR PC

2021 ANTI-VIRUS SUPERGUIDE

FREE AND PAID VERSIONS COMPARED * SHOCK WINNER!

FEATURE

Event on the horizon

Ian Evenden explains how the Sun could one day take out our electronics and communications technology in mere moments. **Page 58**

FEATURE

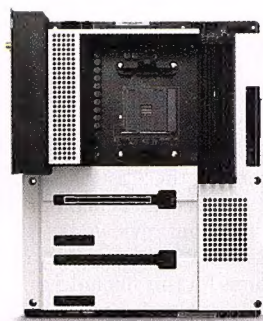
PLUG & PLAY PI PROJECTS

Jonni Bidwell explains how to make the most of the versatile Raspberry Pi device. **Page 66**



MSI OPTIX MPG321UR-QD 32

Is MSI's new gaming monitor all about the Optix, or is it a new benchmark for no-compromise gaming? **034**



NZXT N7 B550
032



QNAP TVS-675 NAS
031



G.SKILL Z51
039



ELGATO FACECAM
040



XFx SPEEDSTER MERC 308 RADEON RX 6600 XT
RDNA2 at a tenuously less expensive price point. **026**

TECHNOTES

- 10 News**
What's happening in tech
- 14 Tech brief**
Will 12th Gen + DDR5 be a disaster for gaming?
- 16 End user**
AI is a human rights problem
- 17 Random access**
World's biggest social media company does more anti-social things
- 18 Two bits**
Intel's 12th Gen architecture
- 19 Tech talk**
Prepare for the DDR5 shift
- 24 Gadgets**
Techy toys and trinkets

THE LAB

- 26** XFX AMD 6600 XT
- 28** MSI GE76
- 29** Seagate Firecuda 530 SDD 4TB & 2TB
- 30** MSI X570S Carbon Max
- 31** QNAP TVS-675 NAS
- 32** Nzxt N7 B550
- 33** Corsair RM850x
- 34** MSI Optix MPG321UR-QD 32
- 35** Asus TUF Gaming VG28UQL1A
- 36** Asus ROG Strix XG16AHP-W
- 37** LG Ultragear Ergo
- 38** Asus ProArt Display 14
- 39** G.Skill Z5i
- 40** Elgato Facecam
- 41** Asus Zenphone 8
- 42** Corsair Airflow 7000D
- 43** Asus Gladius III

FEATURES

- 50 Security Suite group test**
The threat landscape has changed in 2021, and so have the relative strengths of the options you have to stay protected. Nick Ross has the results and the surprise winner
- 58 Event on the horizon**
Ian Evenden explains how the Sun could one day take out our electronics and communications technology in mere moments
- 66 Plug & play Pi projects**
How to make the most of the versatile Raspberry Pi devices

SOFTWARE

- 44** Windows
- 45** Apple Mac
- 46** Apple iOS
- 48** Android
- 49** Linux

PC BUILDER

- 76 System news**
Mark Williams is still waiting for Intel's splash
- 77 Market watch**
A sampling of PC systems available
- 78 Blueprints**
APC's best-value builds
- 82 PC builder masterclass**
High end ITX art

HOW TO

- 88 Quick tips**
Solving a variety of tech problems
- 90 Windows**
Install Windows 11 fresh
- 92 Macintosh**
Play live with your Mac
- 94 iOS**
Give your music a spin
- 96 Linux**
Stress test your CPU

MASTERCLASSES

- 98 Pi**
Building robots in Scratch with GP10
- 100 Coding**
Micro:bit Part 3: The (almost) infinite world of sensors

DOWNTIME

- 102 Maching of the month**
Original Apple Macintosh
- 104 Gaming news**
What's happening, gamers
- 106 Gaming reviews**
High-performance playtime
- 110 Game changer**
Close Combat V: Invasion Normandy
- 114 Chip chat**
The less than serious news page



SUBSCRIBE NOW!

Turn to page 22 now to find out how.



“Championing technology doesn’t mean we’re unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage.”

HOW WE DO IT

Inside APC

Find out all about APC’s editorial policies, test practices, how to read the benchmark results, and more.

APC is Australia’s oldest consumer technology magazine – having been consistently in print for forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We’re also an open church in terms of platforms. We know most people aren’t wed to a single brand’s products and use a variety of devices. And, like you, APC’s journalists want to know what’s good in tech – no matter what platform it resides on.

Independent reviews

Championing technology doesn’t mean we’re unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in APC are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an APC reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

Labs testing

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

In most cases, for the benchmark results published in APC, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we’ve flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred. ■

APC TESTBED

The current APC testbed used in the Labs for benchmarking all components. This testbed is updated as new and relevant technology comes on stream.

CPU	AMD Ryzen 7 5800X
Motherboard	Asus ROG Crosshair VIII Dark Hero
GPU	MSI GeForce RTX 3080 Gaming X Trio
Memory	2x8GB Team T-Force Xtrem ARGB DDR4-3600
Primary SSD	Adata S70 2TB NVMe
Secondary SSD	Samsung 980 Pro 500GB NVMe
Cooling	Nzxt X73 360mm AIO
Case	Thermaltake Core P8
Power Supply	Corsair AX1000

APC AWARDS



APC Hot Product

When a reviewed product scores 4.5 out of 5 or higher, it carries the Hot Award. These are products that exceed expectations and deliver a quality experience up there with the very best.



APC RECOMMENDS

You will see this award if a reviewed product has scored four out of five stars. It means most people can expect satisfying performance from the product, and that we would use it ourselves.

4G/LTE Dual-SIM Dual-Band Wireless VoIP VPN Router

CAT.6 

5GHz 1733Mbps
2.4GHz 600Mbps



BILLION

BiPAC 4520VAOZ R3



PERFECT CHOICE, GENUINE VALUE

Enables high-speed and secured Internet connectivity for home, SOHO, and enterprise users.

- ▶ 4G LTE Mobility
- ▶ Dual Radio/Dual SIMs
- ▶ 4X4(1733Mbps at 5GHz)/3x3(600Mbps at 2.4GHz)
- ▶ Automatic Failover/Failback between 4G/LTE and Gigabit EWAN



au.billion.com

☎ (02) 8318 3777

✉ sales@firstint.com.au

📍 Unit 35, 7-9 Percy Street Auburn NSW 2144

SECURITY

Microsoft will let you remove your account password

Furthering the company's vision for better ways to sign in.

For the past few years, Microsoft has been predicting a future where you don't need a password, thanks to the use of verification codes, biometric identifiers or authentication apps. Now, the company is putting its money where its mouth is and allowing you to take the password off your Microsoft account.

Those who opt out of passwords will be able to use Microsoft's Authenticator app for Android or iOS, Windows Hello facial recognition or fingerprint sensing, security keys or verification codes sent to phones or emails to sign into Microsoft's apps and services.

In a blog post, corporate vice president of Microsoft security, Vasu Jakkal, wrote

that these services include Outlook, OneDrive and Microsoft Family Safety, and that this option will come out over "the coming weeks."

To remove the password, you'll need to have Microsoft Authenticator on your iOS or Android device and connect it to your Microsoft account. Then, you'll have to go to account.microsoft.com, log in and go to "Advanced Security Options." In the "Additional Security" menu, there will be an option called "Passwordless Account" that you can turn on.

This will result in a series of on-screen prompts, which will ultimately leave you sans password. You can add one back to your account – this isn't a mandate just yet.

Microsoft's reasoning here is that passwords aren't user friendly and that they're security risks on their own.

"Updates are often required on a regular basis, yet to create passwords that are both secure enough and memorable enough is a challenge," Jakkal wrote. "Passwords are incredibly inconvenient to create, remember, and manage across all of the accounts in our lives." Microsoft's studies suggest that one in 10 people reuse passwords across different services, while 40 percent use a formula that changes predictably. The company also says that it has become easier for hackers to guess passwords, and points out that once a password hits the dark web, it can be used to easily compromise accounts.

Microsoft's approach runs counter to the other leading idea for increasing security: a mix of password managers with two-factor authentication. Instead of something you know, it's focusing on something you have (a security key) or even something you are (facial recognition).

"Passwords are incredibly inconvenient to create, remember, and manage across all of the accounts in our lives." Microsoft's studies suggest that one in 10 people reuse passwords across different services, while 40 percent use a formula that changes predictably.



GIGABYTE OFFERS REFUNDS, EXCHANGES ON EXPLOSIVE PSUS

Putting an end to the flaming fiasco.

Gigabyte has already issued a voluntary recall for the brand's GP-P850GM and GP-P750GM power supplies, both of which are known to occasionally catch fire. Now, the company has finally put up a fully functioning RMA portal for affected owners that desire a refund or a product replacement.

Not all GP-P850GM and GP-P750GM power supplies are eligible for the refund or exchange. GP-P850GM units must have a serial number between SN20343G031011 and SN20513G022635, while GP-P750GM units must carry a serial number between SN20243G001301 and SN20453G025430.

Owners who purchased their units from an authorised Gigabyte reseller, can opt for a refund or product replacement. Unfortunately, owners that acquired the power supply from a non-authorised seller, such as eBay or Amazon marketplace, are only eligible for a product replacement.



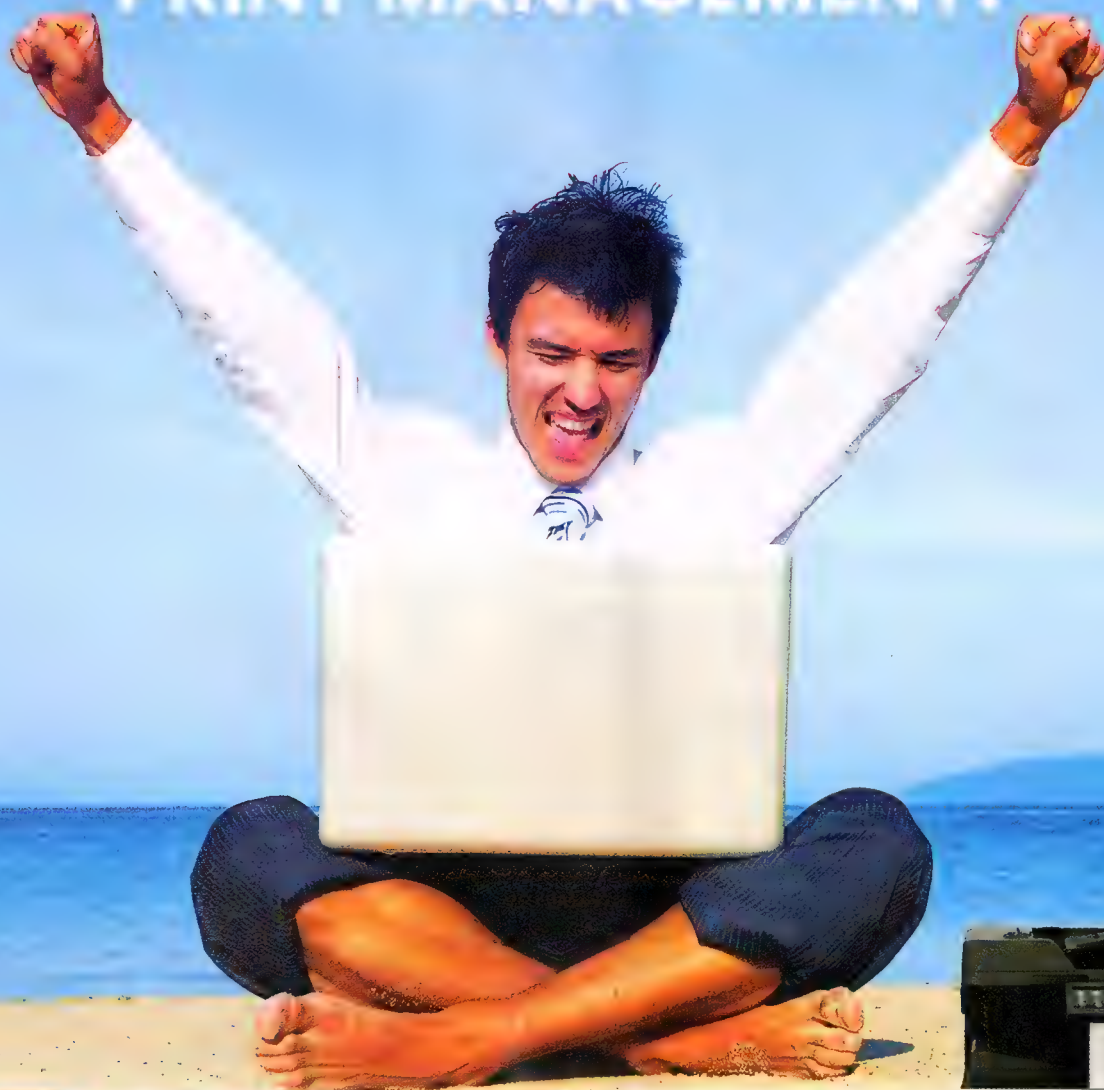
EVGA EXPLAINS WHY ITS 3090S WERE BLOWING UP IN *NEW WORLD*

It wasn't the fan controller after all.

The mystery behind why one brand and model of GeForce RTX 3090 were failing in Amazon's soon-to-be-released *New World* is solved. After some serious investigations into the problem involving X-rays, it has pointed the finger of shame at some dodgy soldering of the MOSFETs on a small batch of cards.

EVGA said it only received about two dozen dead RTX 3090s that had failed from playing the *New World* beta. EVGA sent replacement RTX 3090s to affected gamers after the story broke, and didn't wait for the failed cards to be returned first, turning a potential PR disaster into something of a win, as this is very much not the norm.

DO YOU WANT A **STRESS-FREE** PRINT MANAGEMENT?



FREE
REPAIR &
MAINTENANCE

FREE
UNLIMITED
TONER

SIMPLIFIED
MONTHLY
INVOICING

RELIABLE
TECHNICAL
& CUSTOMER
SUPPORT

SAVE UP TO 70% PRINTING COST



Lexmark XC9235 A3 Colour Photocopier



LexmarkTM



InkMasters
Your Master of Solutions



12 Frankston-Dandenong Rd.,
Dandenong South,
Melbourne, Victoria 3175

1300 898 591
sam@inkmasters.net.au
www.inkmasters.net.au

- Melbourne- Dandenong VIC 3175 (03 9533 0252)
- Sydney- Eastern Creek NSW 2766 (02 7209 6270)
- Perth- Belmont WA 6104 (08 6317 0933)
- Brisbane- Murarrie QLD 4173 (07 3667 9840)
- Adelaide- Beverly SA 5009 (08 6317 0933)

Ink & Toner Cartridges | Printers & Photocopiers | Repair Service | I.T. Support | Managed Print Solutions



Chia Coin miners reselling used SSDs & HDDs as new

The Chia exodus begins.

Chia Coin is an alternative cryptocurrency coin designed to be a greener solution to the whole cryptocurrency craze, and it started off incredibly strong, leading to crushing HDD shortages. However, the currency has now tumbled to roughly 15 percent of its initial peak over the last three months, so miners are reportedly fleeing to other platforms. According to a report from *VNExpress*, some miners are now dumping drives and reselling 'renewed' used SSDs as brand new.

Miners initially purchased massive amounts of storage for Chia plotting,

triggering shortages of SSDs and HDDs. Since then, the cryptocurrency has tumbled in value. Naturally, some miners will try to exit the business and move onto something else, but they'll need fresh capital. That means selling off the existing hardware they used for Chia mining.

These drives aren't worth much, as Chia plotting can destroy average SSDs in less than two months. It's probably only a matter of time before these renewed SSDs filter out to other markets like the rest of Asia, Europe, and the U.S.

Jensen Huang makes *Time* 100 list of influential people

CEOs of Apple, Nvidia, and Tesla among prestige list.

It's no surprise that three CEOs would make the *Time* 100 list of most influential people. This year's list includes Nvidia CEO Jensen Huang, along with Apple's Tim Cook and Tesla's Elon Musk. Nvidia is certainly smaller than Apple or Google, but throughout his career Nvidia's co-founder and chief executive Jensen Huang has had a major influence on such markets as PC gaming and high-

performance computing, and is now helping to develop hardware and software for artificial intelligence applications.

Given how widely AI can be used, Nvidia is certainly among the key high-tech innovators these days, so it's not surprising that the *Time* magazine chose Huang over many other high-tech CEOs. Furthermore, if Nvidia manages to acquire Arm, it will enter yet another new market.



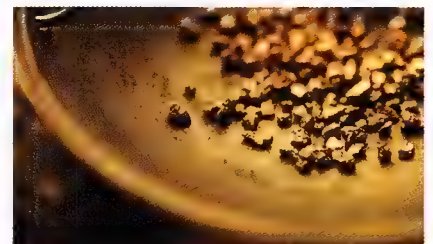
© Western Digital

WESTERN DIGITAL UNVEILS 20TB HDD

Improves hard drives with OptiNAND.

Western Digital has introduced the industry's first 20TB hard drives that integrates an iNAND UFS embedded flash drive (EFD) to improve performance, reliability, and capacity. The company's OptiNAND architecture does not use 3D NAND memory for caching, but to store various metadata to enhance key characteristics of hard drives.

Western Digital's 20TB HDDs with OptiNAND technology are based on nine 2.2TB ePMR (energy-assisted perpendicular magnetic recording technology) platters, triple-stage actuator technology for more precise positioning of read/write heads, an iNAND UFS drive of unknown capacity that uses 3D TLC NAND memory, and the company's custom system-on-chip (SoC) that controls the drive as well as communication between the HDD and the EFD.



© Shutterstock

RARE EARTH METAL PRICING SKYROCKETS

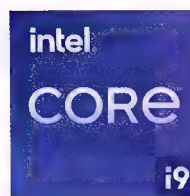
May result in higher electronics pricing.

The semiconductor industry is one of the most complex ventures on the planet, with a supply chain relying heavily on natural resources. We are now at an inflection point for the semiconductor industry – mostly due to its most basic prime matter, rare earth metals which are used as elements for the manufacturing of semiconductors, having seen tremendous price increases in the last year. An interplay between COVID-19-weakened supply chains, soaring demand, and political tensions between the US and China are being pointed as major forces behind the increases.

Even as both superpowers vie for economic supremacy, with China's control of the rare metal earths and the US' blacklisting of several China-based companies and even China-bound exports, the escalating tension between them likely will only push prices of those key materials higher in the long term.

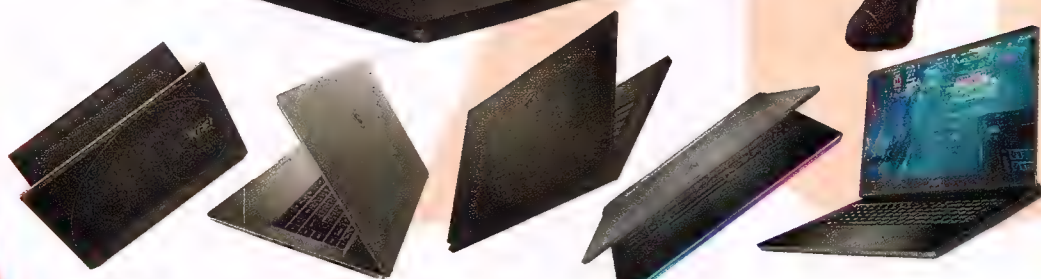


Powered by
up to 11th Gen.
Intel® Core™
i9 processor



START FROM \$1,799 AUD MSI MONTH

SWORD Series



SUMMIT
Series

CREATOR
Series

GS Series

GE Series

GP Series

VIEW DEALS



23/08 - 03/10/2021
T&C'S APPLY

LEARN MORE



OWN THE BATTLEFIELD

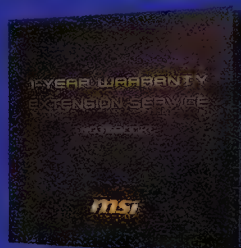
BUY SELECT MSI GEFORCE RTX™
DESKTOPS AND LAPTOPS, GET
BATTLEFIELD™ 2042

*Offer available with MSI GEFORCE RTX 3070, 3070Ti, 3080, 3080Ti, 3090 laptops and desktops

LEARN MORE



2021 EXTRA WARRANTY REDEMPTION



JUL. 15TH - SEPT. 30TH, 2021

LEARN MORE

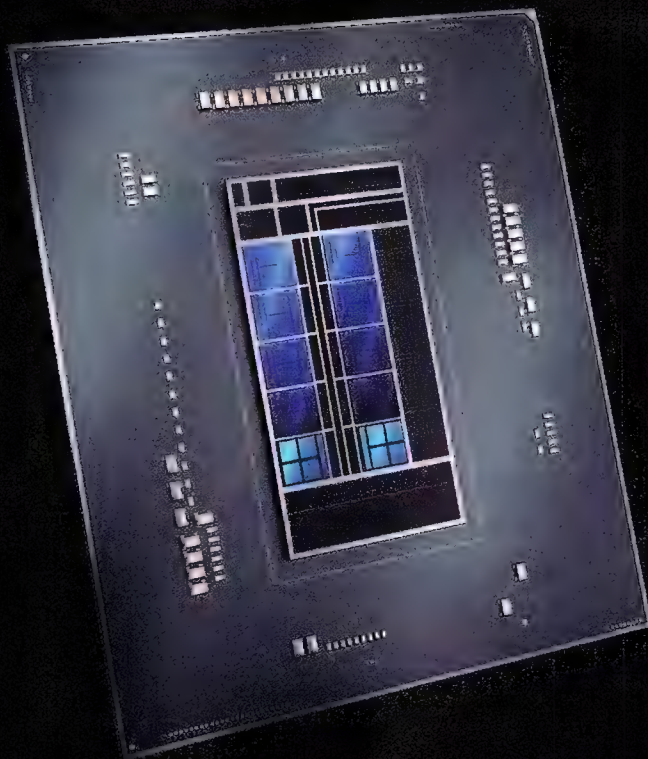


Unleash your creative genius.

Get \$500 in creativity software with
purchase of an MSI laptop featuring a
qualified Intel® Core™ i7 or i9 processor

Luminar MAGIX

Redeem offer by November 30, 2021



There will be much to learn about getting the most from an Alder Lake + DDR5 pairing

TECH BRIEF

12th Gen Alder Lake tested with DDR5-6400 memory

Has unexpectedly high latency, may be terrible for gaming.

A new Alder Lake benchmark has been posted with a for sale listing, potentially showing a sample from Intel's next-gen CPU series running in its new Gear 4 mode. According to @harukaze5719, this latest leak comprised a Core i5-12600K 10-core CPU running the AIDA64 cache & memory test, with a kit of DDR5 memory operating at DDR5-6400. Memory bandwidth was impressive at around 88-90GBps. However, memory latency took a huge hit, running at a sluggish 92.5ns.

According to the listing, the system ran with Gear 4 enabled. In the last decade, Intel hasn't released a single architecture that approached 92.5ns of memory latency. Only AMD's original Zen architecture was capable of such laggy behaviour, and it was known for its memory bottlenecks in that first-generation iteration.

Intel first introduced gear modes with its current Rocket Lake architecture as a way to improve memory support, but at the cost of latency. Rocket Lake offers up two modes: Gear 1 and Gear 2. Gear 1 is the default mode that will run the memory controller and RAM at

the same frequency, resulting in very low system latency. Gear 2 on the other hand reduces the memory clock to run at half the speed of the memory controller clock, or a 2:1 ratio. You sacrifice some memory latency, but you reach higher frequencies, and thus higher bandwidth, as a result.

When we tested both gears we noticed Gear 2 took a noticeable toll on system latency, directly impacting gaming performance. We tested a Core i5-11600K with Gear 1 mode featuring DDR4-2933 RAM, and DDR4-3200 RAM for Gear 2. Despite the faster memory speeds on Gear 2, we found that Gear 1 was consistently faster, with 5 percent better gaming performance. The memory latency results showed a similar trend, with 59.3ns for Gear 2 mode and 52.3ns for Gear 1. The latency results would be even more pronounced if both configurations ran at the same RAM frequency.

With Gear 4 mode, Intel takes things to a whole new level by cutting the memory controller frequency to just a quarter of the memory frequency. While this does allow the chip to support incredibly

fast memory, it should still result in large latency losses.

So if the leaked latency results are true, with Gear 4 nearly doubling the amount of memory latency of Gear 1, then that setting will probably be quite useless for PC gaming and for other consumer-based applications. Generally, system latency is far more important than memory bandwidth, with only a couple of memory-hungry apps actually breaking that rule. So we'll have to see how these changes materialise once Alder Lake launches later this year.

The biggest unknown to all this is DDR5 memory, and what the highest memory frequency will be for the most expensive DDR5 kits. We've already seen DDR5 kits that can hit 12600MT/s, so Gear 4 mode could be advantageous at these speeds and beyond. But for now, it's only a theory. We'll have to wait for reviews (or at least a few more leaks) to see how the new Alder Lake architecture handles DDR5, and if higher gear modes will actually be useful.

AARON KLOTZ ■

PERFORMANCE STORAGE, PURPOSE-BUILT FOR GAMING

BECAUSE THE GAME NEVER WAITS.



NEW WD_BLACK™ SN850
NVMe™ SSD

WD_BLACK™ P50
GAME DRIVE SSD

WD_BLACK™ P10
GAME DRIVE

NEW WD_BLACK™ D50
GAME DOCK NVMe™ SSD

NEW WD_BLACK™ AN1500
NVMe™ SSD AIC

INTRODUCING THE EXPANDED WD_BLACK™ LINEUP

Stop staring at load screens. Increase your capacity and speed to get in fast and take them out faster. The WD_BLACK™ portfolio is purpose-built for gaming.

Available from the following selected Resellers:
Centrecom, MSY, Mwave, PLE Computers, Scorptec & Umart

WD_BLACK™
DRIVE YOUR GAME AT WDBLACK.COM

END USER

AI is a human rights problem

The UN has called for a moratorium on certain kinds of AI, and it's about time, writes Shaun Prescott.

The UN went gloves-off on AI last month, with High Commissioner for Human Rights Michelle Bachelet calling for a moratorium on the use and sale of any AI systems that threaten human rights.

"Artificial intelligence can be a force for good, helping societies overcome some of the great challenges of our times," Bachelet said in a prepared statement. "But AI technologies can have negative, even catastrophic, effects if they are used without sufficient regard to how they affect people's human rights."

She continued: "Artificial intelligence now reaches into almost every corner of our physical and mental lives and even emotional states. AI systems are used to determine who gets public services, decide who has a chance to be recruited for a job, and of course they affect what information people see and can share online."

That reads like a stinging indictment, but it's more subtle: Bachelet isn't talking about all AI: she's not accusing Nvidia's DLSS of human rights abuses, or crap-avoiding Roombas of perpetuating injustice. What she's talking about, it seems obvious, is technology like Amazon's Rekognition. Among other things, that AI technology has been trialed by US law enforcement to identify criminal suspects' faces, though Amazon workers wrote to Jeff Bezos in 2019 to appeal against its sale to the likes of ICE and Homeland Security. Amazon

announced its own one-year moratorium on law enforcement use of Rekognition in June last year, in the wake of the George Floyd protests.

But a moratorium ain't an abandonment. Other companies like Microsoft have actually called on governments to regulate facial recognition technology, especially where it can "increase the risk of decisions and, more generally, outcomes that are biased and, in some cases, in violation of laws prohibiting discrimination." For its own Azure Face recognition software it has adopted a series of self-imposed policies ensuring "fairness" "accountability" and "lawful surveillance," among other things. Washington State instated a law in 2020 putting severe limitations on public sector use of facial recognition, largely thanks to Microsoft's lobbying.

That's arguably one of the biggest considerations on Bachelet's mind, but we've experienced something similar – albeit on a less technologically sophisticated scale – in Australia. Take Robodebt, the Australian government's automated debt recovery technology that caused a stir in 2017 when it was found that some people were being hit with debt notifications they actually didn't owe. The system was also found to issue debts to deceased people, pensioners, and vulnerable people, and has been blamed for suicides. The Morrison government scrapped the



SHAUN PRESCOTT
Author, *PC Gamer*
editor and passionate
technology observer,
Shaun covers trending
tech topics for APC.

technology in 2020.

Algorithms as a replacement for bureaucracy is both incredibly tempting and utterly nightmarish. Tempting for the governments and organisations, scary for the rest of us. And that's not to mention warfare, where AI advancements tend to find their origin and continue to evolve in quite terrifying ways: whack some imperfect facial recognition software into an autonomous military robot and see if it serves up justice.

AI is fascinating tech: it's already changed the world and will continue to do so in ways that we probably can't fathom right now. But the people and organisations in charge of it need to be made to tread carefully. Governments were slow to respond to a lot of internet age technologies and platforms that have irrevocably changed the world, sometimes for the worse. It can't afford to do so with AI. ■

Algorithms as a replacement for bureaucracy is both incredibly tempting and utterly nightmarish. Tempting for the governments and organisations, scary for the rest of us.





RANDOM ACCESS

World's biggest social media company does more anti-social things

Facebook accused of misleading academics, and it's getting investigated by the US Senate Commerce Committee.

Look, we don't want to be covering Facebook again either, but the company it seems is incapable of avoiding serious international scandals for any meaningful length of time. While each of these outrages would be enough to sink plenty of Silicon Valley companies, this particular one seems to be coated in a Facebook-blue shade of Teflon.

Take the second week of September for example. A report by the *New York Times* detailed how Facebook had been providing academics incomplete and potentially misleading data on Facebook misinformation for years. The company had permitted access to its data for researchers studying the spread of misinformation on the site for the last couple of years in order to rebuild trust in the brand, however the *Times* report noted that the data it's been providing included only around half of users in the US, and only ones that engaged at a high level with political content. A Facebook spokesperson explained the issue as a "technical error" and emails to researchers include apologies from Facebook for the "inconvenience [it] may have caused", but the



JOEL BURGESS
When not reviewing PCs for *APC* and writing our funny pages, Joel likes to ponder tech and how it's used.

company also cut off access to the NYU Ad Observatory Project for using its own browser plug-in to collect its own data on the site's political advertising.

A few days later *The Wall Street Journal* published an article on how Facebook gives a select group of VIPs the permission to violate policy guidelines in lieu of a review by employees that generally never eventuate. 'XCheck' (cross check) allows high profile public figures to be 'whitelisted' and avoid immediate content moderation. They also wouldn't be subject to the same sanctions as regular users for major violations. The *WSJ* noted that in 2019 Facebook allowed soccer star Neymar to post a nude photo of a woman that had accused him of rape to tens of millions of fans before the content was removed.

If all this wasn't enough it only took another couple of days before *The Wall Street Journal* released another article accusing Facebook of being fully aware of the harm Instagram is causing teenage girls. The article details the key findings of a concealed internal report by Facebook on social comparisons that explicitly stated "We make

body image issues worse for one in three teenage girls". Facebook also conducted studies on US and UK teens feeling "unattractive" and concluded that 40 percent found those feelings started when using Instagram. Another internal study concluded that Instagram was more geared towards "social comparison" than TikTok and Snapchat, since it more often highlighted user's bodies and lifestyles.

It's perhaps not overly surprising then that lawmakers from the Senate Commerce Committee announced they were launching a probe into Facebook following the *WSJ* report. The Committee even made the statement "It is clear that Facebook is incapable of holding itself accountable. *The Wall Street Journal's* reporting reveals Facebook's leadership to be focused on a growth-at-all-costs mindset that valued profits over the health and lives of children and teens... When given the opportunity to come clean to us about their knowledge of Instagram's impact on young users, Facebook provided evasive answers that were misleading and covered up clear evidence of significant harm." ■



TWO BITS

Intel previews its 12th Generation Alder Lake architecture.

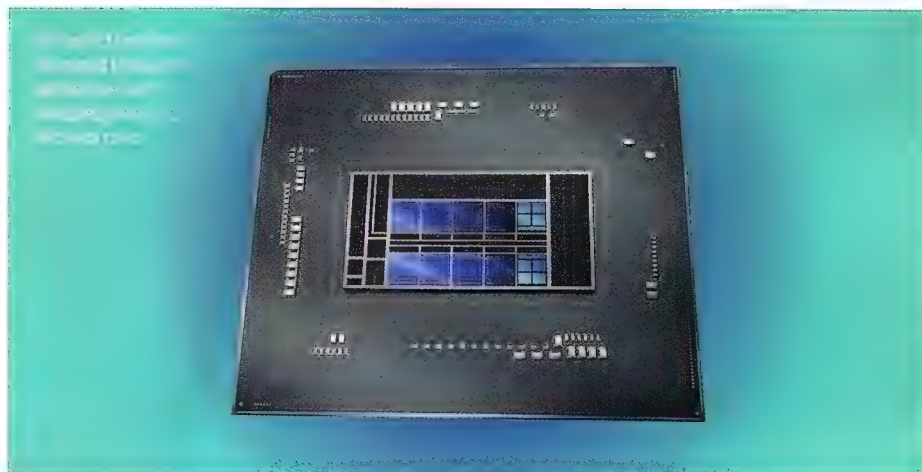
Is this Intel's 'zen' moment?

Things are happening over at Intel. Intel 7 (~10nm) is finally ready for the desktop, Arc GPUs are in the latter stages of development and we're closing in on the launch of hybrid CPUs codenamed Alder Lake. We've had quite a few leaks, titbits and teasers of Alder Lake for most of 2021, but now Intel itself has taken the wraps off its latest and greatest. The fundamental shift to a hybrid architecture, which combines up to eight high-performance cores with eight efficiency-optimised cores, will form the building blocks of the next several generations of Core processors. It represents Intel's biggest architectural overhaul since at least the launch of Sandy Bridge a full decade ago.

The biggest change introduced with Alder Lake is the shift to a hybrid architecture. The high-performance cores will function similarly to what you'd expect from a CPU as we know it, with an improved specification, IPC and a refined feature set. These cores are codenamed Golden Cove. They are joined by a set of efficiency-optimised cores, codenamed Gracemont. These are optimised for low power consumption, yet Intel claims the IPC of these cores is superior to that of a Skylake core. Overall you can think of Alder Lake as a blend of Core and Atom type processors.

These building blocks represent the first steps of a ground up reimagining of Intel's entire product stack, though it will take several years for everything to fall into place. We can expect everything from ultra-mobile devices to laptops to desktops to enterprise to eventually feature a hybrid architecture.

Such a fundamental overhaul will require a lot of software awareness, which could be risky. For the desktop, it's looking like Windows 11 will be the optimal solution for this, though apparently Windows 10 is also supported. Intel's so-called Thread Director is able to send



CHRIS SZEWCZYK

A life-long PC tech enthusiast, Chris has worked across the industry in many areas as a product and technology expert.

tasks to either the performance or the efficient cores based on their needs. It will be interesting to see how software performs with a hybrid architecture. Such a shift is not a trivial thing for software developers. Older software may encounter issues.

Then we have the shift to 10nm, or Intel 7 according to Intel's new parlance. After being stuck on 14nm for years more than it would have wanted, this shrink is the first of many steps towards Intel's goal of recapturing its process leadership.

12th Generation CPUs will be joined by a top-to-bottom line up of 600 series motherboards, from the enthusiast Z690, to midrange H670 and B650 boards and finally the budget-oriented H610 range.

The platform will see the introduction of PCI Express 5.0 along with DDR5. These two features alone would represent a huge upgrade, but when you add hybrid cores and a long-awaited process shrink to the mix, it's no understatement to say that Alder Lake is a critical launch for Intel.

There's still a lot we don't know about Alder Lake. Its relative performance and power consumption will be key. If Intel can execute, and we get the feeling that it's confident it can, then the back end of 2021 is looking very exciting if you're a PC enthusiast. You can be sure that we at APC will be all over it. We look forward to getting our hands on the CPUs in the near future. ■

It will, of course, require a new motherboard and new DDR5 memory.



Prepare for the DDR5 shift

Buckle your wallets, because the Intel 12th Gen Alder Lake and AMD AM5 platforms will entail some costly upgrades.

Modern PCs utilise DDR4 memory, but that's all set to change with the next generation CPUs and platforms, ushering in a new era of memory bandwidth and capacity. The last time desktop PCs went through such a transition was five years ago, and early adopters often pay the price. Here's what to expect from DDR5.

DDR5 slots aren't compatible with DDR4 slots. We might see motherboards that support both DDR4 and DDR5, but you'll have to choose between one or the other – you won't be able to install both memory types at the same time. DDR5 slots will maintain the same pin count as DDR4, 288-pin, but the pin layout will be different, and the slots are keyed with a notch so that you can't put in the wrong type of memory. Voltages are also different, with DDR5 dropping to a standard 1.1V compared to 1.2V on DDR4.

DDR5 reorganises the memory chip layout too. DDR5 supports up to 32 memory banks distributed over eight bank groups, compared to 16 banks and four groups on DDR4.

Besides improved efficiency and throughput, DDR5 boosts the clock speeds. The official JEDEC standard for DDR5 starts at 3200MHz, matching the fastest official DDR4 JEDEC speed. Maximum official speeds extend to 6400MHz. That means a typical dual-channel desktop or laptop memory configuration will have a maximum bandwidth of 102.4 GB/s – something that should help improve integrated graphics performance. There will inevitably be overclocked DDR5 chips that reach higher speeds. The fastest DDR4 kits can break 5000MHz already, and there are already plans for at least DDR5-8400.

It's not just speed, though. Capacities are set to get a massive boost. DDR4 chips right now top out at 16GB, which means the typical DIMM with eight chips on each side has a maximum capacity of 32GB. DDR5 is set to have chip capacities of up to 64GB, meaning DIMMs could have up to four times the capacity – 128GB DIMMs, coming in the next year or so!

There's more to life than just speed and capacity, however, and



JARRED WALTON

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

this is where we have to hit pause on all the excitement. There are many applications – including games – that respond better to reduced memory latency rather than more bandwidth. Official JEDEC standards for DDR4 have timings of 20-20-20 for DDR4-3200 as the best speed, though enthusiast kits with 14-14-14 timings exist. That's 12.5ns of CAS Latency for CL20 and 8.75ns for CL14 DDR4-3200.

The fastest official DDR5-3200 timings now are 22-22-22, which means 13.75ns of latency, and the fastest DDR5-6400 memory has 46-46-46 timings, or 14.375ns latency. We'll see what real-world timings end up shipping, but DDR5-3200 kits that adhere to JEDEC standards could perform worse than current DDR4-3200 kits in situations where responsiveness and latency are more important than raw bandwidth.

The same thing happened with the transition between DDR3 and DDR4 memory, so there's nothing new about these concerns. Over time, we expect even 'normal' DDR5 kits will end up outperforming enthusiast DDR4 kits, but it will take time to reach that point, and there will undoubtedly be a transition period where DDR5 kits cost significantly more than equivalent performance and capacity DDR4 kits. ■

There's more to life than just speed and capacity, however, and this is where we have to hit pause on all the excitement. There are many applications – including games – that respond better to reduced memory latency rather than more bandwidth.



HOW IT'S DONE

TAKING THINGS APART AND HAVING A POKE AROUND



PS5 DualSense Controller

The DualSense controller turns out to be among the PS5's biggest upgrades.

While we were waiting for our PS5 to arrive, we got busy on the DualSense controller. There's enough new stuff packed in to make this a meal on its own:

Major tech specs

- Space-age adaptive triggers
- Top-of-the-line haptic system
- SIE CXD9006GG – likely a custom Sony chip doing all the work
- Dialog DA9087 PMIC
- Realtek ALC5524 audio codec
- Nuvoton NAU8225 3.0 W Class-D Audio Amplifier
- 5.7 Wh Li-ion Battery

Key findings

The new design is so sleek that there are zero visible screws. We aren't fazed though – where there's a seam, there's a way! The black trim cover around the joysticks unclips with ease, revealing two screws near the tips of the handles. Two more screws are hidden under the L1 and R1 buttons, which come up with a little clip-prying (and potential flying).

Lift off! Four Phillips screws and some clips are the only things standing between customers and an open DualSense controller. Just like the DualShock 4 and DualShock 3,

the DualSense battery has a tough plastic shield and isn't glued in place. For battery-swapping serviceability, this beats almost any modern smartphone. This grey monolith clocks in at 5.7 Wh – a sizable increase from the DualShock 4's 3.7 Wh pack. There's a reason for that extra juice: something has to power all this tech. The new DualSense cell is more in line with the 5 Wh pack in Nintendo's Switch Pro Controller, which is also easy to replace.

Next up, out come the guts: button sensors, motherboard, haptic drivers, and adaptive triggers, all mounted to a black midframe. From this perspective, it's clear how much faith Sony has in the DualSense's upgrades. Half the internal volume is dedicated to the triggers and haptics! Both adaptive trigger assemblies connect with cables, but the haptic drivers, USB-C port, and joysticks are all held down by soldered connections.

Let's dig into this classified alien tech... er, variable resistance trigger [Image A]. The trigger works normally without any of the mechanics active, making contact with a button on the blue ribbon



Image A: Alien tech, or the latest brilliance in analog controls?

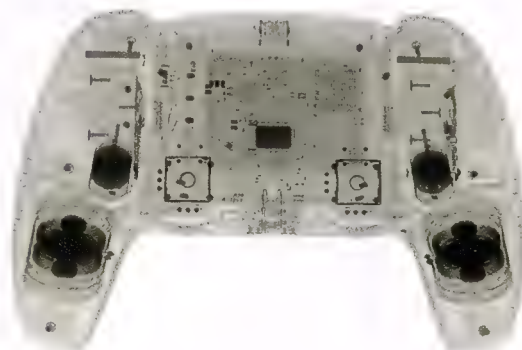
cable. But game developers can choose to program the controller to precisely adjust how difficult the trigger is to pull. The silver motor spins the white worm gear, which drives the black lever arm up and provides resistance to the trigger's lever action, adding another level of feedback to the controller.

With all the easily replaceable parts out, we're down to the soldered-on bits. First off are the two Foster-branded voice coil actuators driving the haptics system. Next: the two joysticks. These look identical to the Alps-brand sticks from the DualShock 4. Compared to these, a Joy-Con joystick replacement is a breeze. PlayStation joysticks are less prone to drift than the notoriously drifty Joy-Cons, but soldering them on is a big miss. Finally, the USB-C port: another high-wear component that we'd prefer to see easily replaced.

The DualSense controller turned out to be among the PS5's biggest upgrades. As a final treat, here's an X-ray look at all the DualSense we just dismantled [Image B] thanks again to our friends at Creative Electron. We also owe a huge thanks to iFixit contributor Chunglin Chin, who did the detective work needed to ID all those chips in the motherboard steps. Great job!

Repairability Score: 7 out of 10 (10 is easiest to repair). ■

Image B: Nothing says teardown like a snazzy X-ray eh?

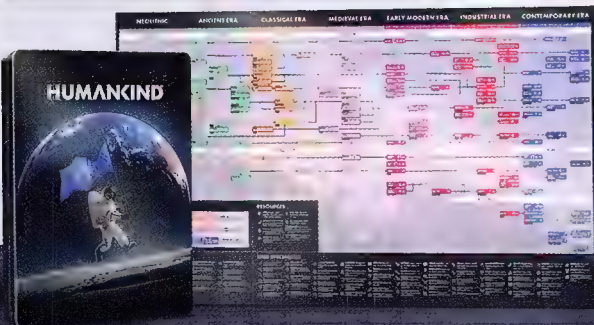




HUMANKIND



OUT 17TH AUGUST 2021



HUMANKIND NOTRE-DAME PACK



INCLUDES:

- LIMITED EDITION STEEL CASE
- TWO-SIDED DECISION COIN
- DOUBLED-SIDED UNIT & TECH TREE POSTER
- HUMANKIND DIGITAL SOUNDTRACK
 - NOTRE-DAME DLC PACK
- BOUDICCA, LUCY & EDGAR ALLAN POE AVATAR SETS AND PLAYER ICONS



PG

Mild themes
and battle violence,
online interactivity

HUMANKIND.GAME

GAMES2GETHER

STEAM

AMPLITUDE

SEGA

© 2021 Amplitude Studios SAS. All rights reserved. HUMANKIND, the HUMANKIND logo, SEGA and the SEGA logo are either registered trademarks or trademarks of SEGA Corporation or its affiliates. SEGA is registered in the U.S. Patent and Trademark Office. GAMES2GETHER, Amplitude Studios and the Amplitude Studios logo are either registered trademarks or trademarks of Amplitude Studios SAS. All other trademarks, logos and copyrights are property of their respective owners. Artwork not final.

SPECIAL
OFFER

SPECIAL OFFER

Subscribe to *APC*

The go-to resource for PC enthusiasts



SCAN ME

Simply scan the QR
code above with your
smartphone camera



All the convenience of *APC* delivered
direct to your door. Get the print edition
home delivered for a year for \$79

Save up to 47% off the newsstand price Get the print
edition home delivered 24 issues only \$139.00
– that's just \$5.79 per issue!

SPECIAL OFFER

APC digital edition also available

Subscriptions also available for Apple
and Android devices.

APPLE OFFER

Free 30 day APC
app subscription trial.
Read our latest issue
free today



The Apple edition for iPhone,
iPad and iPod touch
tinyurl.com/APCAPPLESTORE
From \$4.99 an issue

The Zinio edition for all
Android devices
apcmag.com
From \$4.99 an issue

Two easy ways to subscribe to APC magazine:

VISIT www.techmags.com.au or CALL (02) 8227 6486



SCAN ME

TERMS & CONDITIONS: This offer expires October 31st 2021, and is available to subscribers within Australia only. Please allow 6-8 weeks for delivery of your first issue. For full terms and conditions, see: <http://techmags.com.au/style/images/FutureTC.pdf> Please see our privacy policy on page 3. *Six issues for \$49, then \$49 charged to your credit or debit card every six issues thereafter on auto-renewal (playback); 32x22x1.7cm; 1.78kg.

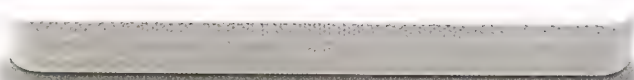
GADGETS

NICE LITTLE THINGS.

\$499.95 | [bose.com.au](https://www.bose.com.au)**Bose QC45**

The new QC headphones are quieter and comfier.

Before the Sony's WH range of ANC headphones arrived on the scene, Bose's QC cans were top dog in premium noise cancelling and they haven't lost that pedigree. It's the simple things that make the new QC45 headphones special. Quiet and aware modes allow you to engage and shut off from the world at the flick of a switch and improved voice isolation technology makes calls and video conferences even clearer. The QC 45s promise 24 hours of continuous playback and all-day comfort, weighing in at just 240 grams, so they'll also be great for travel when we're allowed to do that again.

\$699 | [sonos.com/en-au](https://www.sonos.com/en-au)**SONOS BEAM (GEN 2)**

Sonos's affordable soundbar gets Dolby Atmos.

We were pretty stoked with the original Sonos Beam's ability to bring great quality sound to anyone who couldn't justify forking out another grand or more for audio that matched their TV. The new Beam (Gen 2) comes in at the same \$699 price as its predecessor, but has been updated to include improved speakers, Dolby Atmos 3D Audio compatibility and new high resolution audio streaming abilities. The Beam (Gen 2) can still be paired with a Sonos Sub and One SL speakers for a full surround sound experience if you want to piece together a home theatre sound system over time.

\$599.95 | [gopro.com/en/au](https://www.gopro.com/en/au)**GOPRO HERO 10 BLACK**

GoPro's new Hero is a smooth operator.

The new Hero 10 Black's hero feature is the GP2 processor, allowing the camera to capture footage at double the framerates of its predecessor. If 5.3K at 60fps, 4K at 120fps, or 2.7K at 240 frames per second isn't enough of an update, then there's also faster transfer speeds, smoother preview screens, improved digital stabilisation and a tougher lens cover to make you excited about the update. Other than being fractionally lighter, the new camera is the same dimensions as the Hero 9 Black, so you can use any existing mods or accessories you might already have.



From US\$399 | apple.com/au/apple-watch-series-7

Apple Series Watch 7

Is it time to update your smartwatch?

If you're part of the Apple clan then the Apple Watch Series 7 is a pretty impressive addition to your tech tools. The update features thinner bezels and a more rounded shape with the same 18-hour battery life and a stronger, 50m water resistant screen. The Apple Watch Series 7 is up there with the most advanced fitness trackers around, offering ECG, GPS and Blood Oxygen tracking to map exercise activities precisely. It also gets a way brighter screen and a mini keyboard so you can type message responses and search for things if you can't bear Siri.



\$269.95 | fitbit.com

FITBIT CHARGE 5

Fitbit's feature-rich fitness band knows when to hit the gym.

Fitbit's most advanced range of fitness trackers has a new sleek update to show off. The Charge 5 is packed with novel health tracking metrics like a Daily Readiness score that'll help regular trainers determine if they've recovered enough from their last session. The new device keeps the Stress Management, Heart Health and Cardio Fitness Level metrics going to ensure you know as much about your health as possible and it doesn't lose the 5ATM water resistance, seven day battery life and sturdy build quality that allows it to go anywhere you do.



\$250 | www2.razer.com

RAZER WOLVERINE V2 CHROMA

A colourful contender to the Xbox Elite Wireless controller.

Razer's ultra premium Xbox/PC controller the Wolverine V2, has a new update dubbed Chroma. Yes, it's got a new strip of customisable LED lighting that you can sync with other Razer RGB kit, but the new controller also brings with it Razer's Mecha-Tactile Action buttons that reportedly offer faster actuation time, six additional multi-function buttons and interchangeable thumbstick controllers. A toggle under the triggers allows you to abbreviate the actuation point for hair-trigger responses in shooters or extend it for graduated acceleration in racers. It's also got a USB-C connection, which is a little more versatile these days.





\$849 | www.xfxforce.com

XFx Speedster Merc 308 Radeon RX 6600 XT

RDNA2 at a tenuously less expensive price point.

Gamers are crying out for affordable GPUs. For all the talk about big Navi, RTX and ray tracing technologies, those cards are all priced at levels well above what the majority of gamers are willing to spend. Both the 6700 XT or RTX 3060 have crept back up to well over \$1,000. At around \$849 (and rising), the 6600 XT is still an expensive GPU. Does it offer enough value to compel gamers to upgrade from cards they've been using for years? We have XFX's Merc 308 card in for review, but first, let's take a look at what's under the hood.

The RX 6600 XT features the new Navi 23 GPU, the third RDNA2 GPU to be released. We can probably expect a cut down 6600 non-XT to appear later. The Navi 23 GPU contains 11.1 billion

Specifications

XFx Speedster Merc 308 Radeon RX 6600 XT; 2048 Shader Cores; 2,188MHz Base Clock, 2,607MHz Boost Clock; 8GB 16Gbps GDDR6 memory, 256GB/s Memory Bandwidth; 3x DisplayPort 1.4a, 1x HDMI 2.1; 1x 8-pin Power Connector, 160W TDP.

transistors in its 237 mm² die area. It contains 2,048 Stream Processors, which compares favourably to the 2,560 of the \$1,000+ 6700 XT. But here, significant compromises start. The 6600 XT drops to a 128-bit memory bus though its 8GB of reasonably fast 16Gbps GDDR6 memory still manages to provide 256GB/s of bandwidth. The 6600XT contains just 32MB of Infinity Cache whereas the 6700 XT includes 96MB.

Perhaps the most unusual design decision was to limit the card to PCIe 4.0 x8. This is equivalent to PCIe 3.0 x16, but

if you use a 6600 XT in a PCIe 3.0 motherboard, of which there are countless millions in gaming machines around the world, then you'll be limited to PCIe 3.0 8x. So, other than the 8GB of RAM, which is fine for a 1080p card, the 6600 XT has specs that should relegate it to the budget end of the market in normal times. A 128-bit card with a 237 mm² die should not carry such a price premium.

There aren't any reference cards for this release, so AMD sent over an XFX Merc 308. It's a very nice looking card with its black shroud and silver highlights. It features a boost clock of up to 2,607MHz, which is a good example of the capabilities of TSMC's 7nm process. Such clocks without having to resort to extreme levels of power consumption is quite a feat.

The card features a standard complement of three v1.4 DisplayPorts and a single HDMI 2.1 port. The PCB contains an eight phase VRM, powered by a single 8-pin power connector. This means you get up to 225W of power on tap, which is more than enough to handle the 160W total board power of the card. You also get dual BIOS, though they are identical to each other.

The card really does look great. The side of the card features backlit XFX and Radeon 6600 XT branding. There's a full length backplate and its triple fan cooler should have no problem keeping the Navi 23 GPU cool. Its cooler is well designed, if not

At around \$849 (and rising), the 6600 XT is still an expensive GPU. Does it offer enough value to compel gamers to upgrade from cards they've been using for years?

	Temperatures°C		3DMark			
	Idle	Load	Time Spy Extreme	Fire Strike Extreme	Port. Royal	RT Feature test
Nvidia GeForce RTX 3060 Ti	39	66	5,898	14,220	7,035	27.18
Nvidia GeForce RTX 3060	38	63	4,209	9,998	4,946	18.98
AMD Radeon RX 6700 XT	40	79	5,553	16,441	5,824	13.21
XFx Merc 308 Radeon RX 6600 XT	38	73	4,497	12,404	4,380	10.64
AMD Radeon RX 5600 XT	38	77	3,526	9,584	N/A	N/A

If AMD is to justify prices that are nudging \$800 or more then it needs to perform. It beats out the insanely priced RTX 3060 but trails the RTX 3060 Ti. It's also a significant improvement over the last generation 5600 XT.



overkill for this class of card. The memory and VRM are cooled too.

If AMD is to justify prices that are nudging \$800 or more then it needs to perform. It beats out the insanely priced RTX 3060 but trails the RTX 3060 Ti. It's also a significant improvement over the last generation 5600 XT. In general, the 6600 XT shows itself to be a very good 1080p card, surpassing 60fps and often by a lot, in all of our game benchmarks apart from *Metro Exodus*. It's capable at 1440p too, though you might have to dial the eye candy back a notch in some titles to maintain a smooth frame rate. The XFX Merc is also one of the quietest cards we've ever tested; though its temps can hit the mid 70s, it still holds a boost clock above 2,500MHz. XFX has clearly tuned the Merc 308 for silence. That suits us very nicely.

The XFX Merc 308 6600 XT is ostensibly quite a fine graphics card, though its 128-bit bus and PCIe 8x limitation count against it. But at over \$850, it's poor value. In fact, we expect it to climb in price even further. If we look at the base spec, the 6600 XT should sit in the budget to mid range region, and not nudge \$1,000. A wise old reviewer once said: "There are no bad GPUs, only bad prices". That perfectly sums up the 6600 XT. If and when the card assumes a reasonable pricing position, we'd be happy to recommend it, but at these prices, it's a tough one to recommend.

The XFX 6600 XT is a gorgeous and capable 1080p card, but like too many 2021 GPUs – it's too expensive. **Chris Szewczyk**

★★★★☆

	Metro: Exodus		F1 2020	
	1920x1080 Ultra Preset	2560x1440 Ultra Preset	1920x1080 Ultra High Preset	2560x1440 Ultra High Preset
	Avg	Avg	Avg	Avg
Nvidia GeForce RTX 3060 Ti	44.3	39.1	148	117
Nvidia GeForce RTX 3060	35.4	30.1	112	86
AMD Radeon RX 6700 XT	49.9	42.4	140	112
XFX Merc 308 Radeon RX 6600 XT	42.9	35.6	118	93
AMD Radeon RX 5600 XT	29.3	25.3	95	76

	Middle Earth: Shadow of War		Total War: Warhammer II	
	1920x1080 Ultra Preset	2560x1440 Ultra Preset	1920x1080 Ultra Preset	2560x1440 Ultra Preset
	Avg	Avg	Avg	Avg
Nvidia GeForce RTX 3060 Ti	141	103	105.8	78.2
Nvidia GeForce RTX 3060	108	77	84.6	58.3
AMD Radeon RX 6700 XT	151	104	104.9	75.1
XFX Merc 308 Radeon RX 6600 XT	116	76	80.9	55.1
AMD Radeon RX 5600 XT	88	58	62.8	44.9

	Civilization VI		Ghost Recon: Breakpoint	
	1920x1080 Max Settings	2560x1440 Max Settings	1920x1080 Ultimate Preset	2560x1440 Ultimate Preset
	Avg	Avg	Avg	Avg
Nvidia GeForce RTX 3060 Ti	174.7	142.7	97	77
Nvidia GeForce RTX 3060	127.3	103.1	78	61
AMD Radeon RX 6700 XT	183.8	148.6	106	81
XFX Merc 308 Radeon RX 6600 XT	143.5	116.3	82	61
AMD Radeon RX 5600 XT	122.9	97.9	73	52

\$5,999 | msi.com

MSI GE76 Raider

For those that need top performance at any cost.

If someone wrote you a blank check and said get whatever gaming laptop you want, then you'd probably go for something like MSI's GE 76 Raider. Everything from the keypad to the GPU is top shelf and supercharged. While you probably wouldn't want to make it a regular thing to carry around this 2.9kg 17.3-incher, it is at least possible to move it from place to place when you really need to.

There's quite a range of units available locally spanning from devices with an 11th generation Intel Core i7 CPU, Nvidia RTX 3060 GPU and a QHD 165Hz screen for \$3,299, to a device with a Core i9 CPU, Nvidia 3080 GPU and a 4K 120Hz display for \$7,299.

Considering this oversized laptop is designed to be the pinnacle of performance, you'd be forgiven for wondering why MSI would bother including an option with an RTX 3060. MSI has seriously overclocked this GPU, adding 15W and 102MHz to the maximum compatible power and boost-clock speeds of the stock Nvidia card. To put that in perspective, it's drawing the same power as the RTX 3080 on the next most powerful system we've tested this year. So it's not your average 3060 GPU.

We benchmarked a unit with an Intel Core i9-11980HK CPU, Nvidia GeForce RTX 3080 GPU, 32GB of RAM, and a 17.3-inch QHD screen with a



Specifications

W10 Home 64-bit; 17.3-inch 165Hz IPS display at 2560 by 1440 pixel resolution; Intel Core i9-11980HK; Nvidia GeForce GTX 3080 (155W); 32GB RAM; 2TB Gen 4 Samsung PCIe SSD; 95Wh battery (5h20min 1080p movie playback); 39.7x28.4x2.6cm; 3kg.

165Hz refresh rate that goes for \$5,999. While it is running Intel's top 11th generation laptop processor, the i9-11980HK is a bit of a flop sadly, performing within a few percent of cheaper CPUs like AMD's Ryzen 9 5900HX, and is generally less than 10 percent faster than an i7-11800H, even with ideal cooling architecture.

While it's not a standout performer in general processing power, the CPU is at least able to provide solid support for the GE76 Raider's various overclocked GPUs. Generally the performance of the 155W RTX 3080

was between three and nine percent better than 3080s with power draws around 125W, but we did record fps bumps up to 17 percent in more demanding titles like *Tom Clancy's: The Division 2* using 1080p Ultra settings. There's potential for even bigger performance bumps for high resolution 4K or ray tracing applications.

If you need the best performing gaming laptop at any cost then the MSI GE76 Raider is the device for you, but there are some pretty apparent diminishing returns. Across our suite of gaming benchmarks this \$5,999 device gets 52.8 percent better framerates than a \$2,899 Asus ROG Strix G15 with an AMD Radeon 6800M. Against the \$3,499 Aorus 15P YD with a 130W 3080 you'll see an average of 9.1 percent better framerates and there was only an average 0.2 percent difference between the performance of the GE76 Raider and an Alienware's \$4,499 M15 R6.

A large 95Wh battery provides enough power to keep this unit running for over five hours in both work tasks and 1080p movie playback.

Considering this oversized laptop is designed to be the pinnacle of performance, you'd be forgiven for wondering why MSI would bother including an option with an RTX 3060.

	MSI GE76 Raider	Alienware m15 R6
PCMark10 - Overall (score)	6,974	6,777
Max CPU Temperature (C)	100	100
1080p movie playback (HH:MM)	05:21	05:01
HWBot x265 - 1080p (Ave fps)	58.421	54.721
3DMark Time Spy (score)	11,188	10,817
The Division 2 - 1080p Ultra (fps Av.)	111	92
CrystalDiskMark Read (MB/s)	6,698	3,221
CrystalDiskMark Write (MB/s)	5,032	3,019

A gaming laptop that's really more like an expensive moveable gaming PC.

Joel Burgess

★★★★★

\$705 (2TB), \$1,375 (4TB) | www.seagate.com

Seagate FireCuda 530 2TB and 4TB

Seagate shakes up the SSD market.

We've been waiting in anticipation for the release of Seagate's FireCuda 530 series of PCIe 4.0 NVMe drives. If you tend to think of Samsung or WD when it comes to high performance SSDs, you can add Seagate to that shortlist. Let's not mess around, the FireCuda 2TB and 4TB drives we have in for review are at least the equal of any SSD on the market. They are confirmed compatible with the PS5 as well.

Both the Seagate FireCuda 530 2TB and 4TB are 2280 (80mm length) M.2 drives. Both make use of brand-new high-performance Micron 176-Layer TLC NAND paired with a Phison PS5018-E18 controller. The rated sequential read and write speeds for both capacities is 7300/6900 MB/s. the smaller 1TB and 500GB drives fall back a little from there.

Our samples don't come with any heatsink, but there are versions that include a custom heatsink developed in partnership with EKWB. Which one you go for will depend on your motherboard. It will be interesting to compare the temperature results between the two versions.

Both drives raise the bar when it comes to endurance ratings. The 2TB model comes with a massive 2550 TBW endurance rating, while the 4TB ups this to 5100 TBW, meaning you could write 1TB per day for 14 years if you like. These ratings illustrate the confidence Seagate has in its product. Both drives come with the usual features like Trim support and S.M.A.R.T. reporting, but curiously, not AES256 encryption. Perhaps this is Seagate deciding it's not important for a 'gaming SSD'. With the death of Optane, these drives would make stunning workstation-class SSDs, particularly when



Specifications

Seagate FireCuda 530 M.2 NVMe SSD; PCIe 4.0 x4; Phison PS5018-E18 controller; Micron 176L TLC NAND; 7300 MB/s sustained read, 6,900 MB/s sustained write; 1M/1M read/write IOPS; 2,550 (2TB) & 5,100 (4TB) TBW endurance; Five year warranty.

you consider Seagate's excellent data rescue plans.

We must mention Seagate's DiscWizard drive imaging tool and its Seatools app. These are every bit as good as Samsung and WD's software suites, if not better, particularly if you are a fan of Acronis True Image.

Both FireCuda drives are very expensive relative to their competitors. They need to perform, and they do. We've tested a lot of Phison based drives. They tend to excel at sequential reads and particularly write tasks, but trail the WD SN850 and Samsung 980 Pro drives in random read benchmarks. No more. The FireCuda 530 drives can match or beat them, and when you add its leading sequential performance and endurance, the Seagate 530 is the new SSD king.

We ran the 2TB FireCuda 530 through our suite of tests and made note of the highest recorded temperature. At a peak of 71C it's one of the warmer drives, but

thanks to the high throttling threshold of 90c, we saw no throttling of any kind throughout our testing. Very nice!

Seagate held back while other manufacturers released Phison E18 drives. It appears as though it was time well spent. The use of the Phison E18 controller along with the latest and greatest Micron 176L flash elevates the FireCuda 530 to the head of the pack, though you'll have to pay a pretty penny for the privilege of owning one. When combining those stunning endurance ratings with awesome performance, if you had any thoughts that Seagate might be left behind while Samsung and WD locked up the market, well, Seagate has plenty to say about that.

The Seagate 530 SSDs take the SSD crown but as usual, the best comes at a price. **Chris Szewczyk**

2TB ★★★★★

4TB ★★★★★

	MSI Spatium M480 2TB	Western Digital Black SN850 1TB	Seagate FireCuda 530 4TB	Seagate FireCuda 530 2TB
Crystal Disk Mark - Sequential Read MB/s	7,137	7,071	7,243	7,368
Crystal Disk Mark - Sequential Write MB/s	6,876	5,229	6,946	7,038
Anvil Storage Utilities - 4K Random Read MB/s (seconds) Queue Depth 1	68.47	82.42	80.28	80.68
Anvil Storage Utilities - 4K Random Read MB/s (seconds) Queue Depth 4	273.51	300.22	315.71	319.92
Anvil Storage Utilities 4K - Random Write MB/s (seconds) Queue Depth 1	272.57	255.17	267.77	264.71
Anvil Storage Utilities - 4K Random Write MB/s (seconds) Queue Depth 4	977.30	879.44	929.90	929.56
Anvil Storage Utilities - 4K Random Read IOPS (seconds) Queue Depth 1	17,783	21,099	20,550	20654
Anvil Storage Utilities - 4K Random Read IOPS (seconds) Queue Depth 4	70,018	76,855	80,821	81,898
Anvil Storage Utilities - 4K Random Write IOPS (seconds) Queue Depth 1	69,778	65,322	68,549	68,776
Anvil Storage Utilities - 4K Random Write IOPS (seconds) Queue Depth 4	250,188	225,135	238,054	238,996
Internal File Copy - 30GB of mixed file sizes - Time (seconds)	27	27	27	26
Final Fantasy XIV: Stormbringers - Scene Loading Time (seconds)	8.109	7.680	7.606	7.674

\$499 | www.msi.com

MSI MPG X570S Carbon Max Wi-Fi

Refined and silenced X570.

The X570 chipset is over two years old, a long life in relative terms. Rather than release a new chipset that wouldn't have really been any different, AMD went with a refresh. X570S boards come with upgraded connectivity options including faster than Gigabit LAN or Wi-Fi 6E. Add in a fast PCIe 4.0 x4 drive or two and you've got boards that are right up to date. The S in X570S denotes silence. That means no more tiny chipset fans! One of these new boards is MSI's MPG X570S Carbon Max. This midrange board looks the goods, but is it worth upgrading to?

Looking over the board, your eyes will immediately be drawn to the large heatsinks that dominate the bottom half of the board; this board will accept up to four M.2 drives. Though you'll lose some SATA ports if you populate all four, this ability alone will win over some buyers. Boards with eight SATA ports are becoming rare too, so all things considered, the Carbon Max is one of the best equipped of all AM4 boards if you have a lot of drives.

MSI included a 14+2 phase VRM with 75A stages and 8 and 4-pin power connectors. It's a VRM that will easily handle an overclocked 5950X. The heatsinks are solid with a lot of surface area, and the whole board feels heavy with all that metal. It's also worth mentioning the relatively small amount of RGB onboard. There are just two little splashes, though you do get headers. It would seem we have hit peak RGB!

The rear I/O is very well equipped. You get Realtek 2.5G LAN and Intel Wi-Fi 6E,



Specifications

MSI X570S Carbon Max WiFi; AM4 Socket; Supports AMD Ryzen 5000, 4000, 3000 and 2000 Series Desktop Processors; 4x M.2; 8x SATA; Up to 5x USB 3.2 Gen 2, 8x USB 3.1 Gen 1, 6x USB 2.0; Intel AX210 Wi-Fi 6E; Realtek RTL8125 2.5G LAN; Realtek ALC4080 7.1 Channel HD Audio; ATX Form Factor.

which will handle the networking needs of most typical users. You get ten USB ports made up of two USB 2.0, four 3.2 Gen 1 and four 3.2 Gen 2 ports, one of which is a Type-C. It's nice to see X570 with a HDMI 2.1 port that's perfect for use with one of the very good 5000G series processors. A PS/2 port and CMOS clear button are present, as is a BIOS flashback button, which allows you to flash the board without needing to install a CPU. The audio ports are driven by a Realtek ALC4080 codec.

The X570S Carbon Max performed well, particularly under lightly threaded loads. This was reflected in gaming tests too. The differences aren't significant though, as after years of development and optimising, it's rare to see AM4 benchmark results

outside of a margin of error.

X570S boards are an evolution of X570. If you've got an X570 board already, there's little reason to upgrade, but if you don't, there's a lot of good stuff here. The MSI Carbon Max brings Wi-Fi 6E, it drops the chipset fan, it's got a strong VRM, and you can run 10 or more storage devices. At \$499 it's not cheap, but compared to premium motherboard pricing in 2021, it's pretty reasonable.

A solid X570S entry from MSI, particularly if you have a lot of storage devices. **Chris Szweczyk**

★★★★★

	X264 v5.0 Video Encod- ing - Pass 2 Avg FPS	Cinebench 20 - Multi thread Score	Cinebench 20 - Single thread Score	Blender 2.93 BMW Render Time (secs) Lower is better	7Zip - 19.00 Million Instruction per second	POV-Ray Ray Tracing Pixels Per Second	CPU-Z - Multi Thread Score	CPU-Z - Single Thread Score	Handbrake Video Encoding - 4K 10-Bit HEVC to 1080p FPS
Gigabyte X570S Aorus Master	53.08	6,123	612	159.7	95,573	5,617	6,608	634	75.1
MSI MPG X570S Carbon Max Wi-Fi	53.11	6,099	612	160.1	95,573	5,597	6,608	634	75.1

	3DMark - TimeSpy Extreme Overall score	3DMark - TimeSpy Extreme CPU Score	Civilization VI			Ghost Recon Breakpoint 1080p, Low, Avg FPS	Metro: Exodus		Middle Earth: Shadow Of War - 1080p, Lowest Preset, Avg FPS
			1080p, Ultra, DX12, Avg FPS	1080p, Ultra, DX12, Min FPS	1080p, Ultra, DX12, AI Turn Time		1080p, Ultra, DX12, Avg FPS	1080p, Ultra, DX12, Min FPS	
Gigabyte X570S Aorus Master	8,240	5,563	257	178	6.50	210	129	67.5	329
MSI MPG X570S Carbon Max Wi-Fi	8,269	5,576	257	177	6.50	210	129	67.5	329



\$1,900 | www.qnap.com

QNAP TVS-675

A unique NAS with flexibility and performance that suits media focused use scenarios.

Aimed at small to medium businesses, the six bay TVS-675 uses a unique ZhaoXin KX-U6580 CPU, featuring eight cores that buzz along at 2.5GHz. There aren't many 64-bit X86 alternatives to Intel and AMD, so it's great to see the Chinese-designed-and-built CPU making its way into the world. The TVS-675 can run the QNAP QTS NAS OS or the ZFS based QuTS Hero 128-bit operating system. Thanks to a ZhaoXin C-960 GPU, it also supports real time hardware transcoding.

Our test model came equipped with 8GB of DDR4 RAM, but up to 64GB can be installed. In addition to the six 3.5-inch drive bays, the TVS-675 also has two M.2 2280 PCIe Gen3 x1 slots for adding SSDs. There's also two Gen 3 x4 PCIe slots inside that can handle upgrade cards.

Round the back the NAS has dual 2.5 GbE ports, and you can add in 5GbE or 10GbE for extra speed. There's also dual USB 3.2 Gen 2 (10Gbps) ports (one front with a one-touch copy button, and one rear), plus a USB 3.1 Gen 1 port - all of which can be used for high speed

Specifications

CPU: ZhaoXin KX-U6580 8 Core 2.5GHz; RAM: 8GB DDR4 (upgradeable to 64GB); Drive Bays: 6x 3.5-in, 2x M.2 2280; LAN ports: 2 x RJ-45 2.5GbE; PCIe Expansion: 2x Gen 3 4x Slot; USB 3.2 ports: 3x (2x 10Gbps); Warranty: 3 Years.

storage, or connecting to a range of compatible USB devices. Finally there's also an HDMI 2.0 port, supporting up to 4K resolution at 60Hz.

The TVS-675 is well laid out inside, with airflow direct from the intakes, over the M.2 slots and ram, before cooling the CPU. Adding six Seagate IronWolf Pro NAS drives to the tool-less bays (plus an NVME M.2 SSD) for testing was fast and easy. Exact performance will depend on your drives and network, but we were easily able to saturate the 2.5GbE during sequential transfers, showing the ZhaoXin CPU has enough grunt to avoid bottlenecks. With the right network setup, you can also have the dual 2.5GbE ports act as one, for 5 GbE speeds, or drop in a 10GbE PCIe card. Random access testing tells a similar story - the TVS-675 has plenty of performance to get the most from your drives. We managed excellent sequential reads and writes up to

288MB/s and 261MB/s respectively, and great random access at 121MB/s reading, and 116MB/s writing.

The NAS handled a lot of concurrent use before we saw performance drop - though extra RAM for virtual machines made a big improvement. The ZhaoXin chipset competes well with other mid-range NAS CPUs, especially thanks to transcoding, and the eight cores make up for the lack of hyperthreading. We saw somewhat higher idle power usage compared to equivalent NAS, but nothing problematic. Transcoding and 4K media playback over HDMI was also smooth and problem free.

The list of apps available for the TVS-675 is too long to cover here, but they clever everything from backups, through to productivity and security. A key advantage compared to similar NAS such as the QNAP TVS 673A is the built-in GPU for transcoding and HDMI output. All in all the QNAP TVS-675 is a very upgradeable, well priced NAS with plenty of performance for demanding business needs.

Our test model came equipped with 8GB of DDR4 RAM, but up to 64GB can be installed. In addition to the six 3.5-inch drive bays, the TVS-675 also has two M.2 2280 PCIe Gen3 x1 slots for adding SSDs. There's also two Gen 3 x4 PCIe slots inside that can handle upgrade cards.

The QNAP TVS-675 is an excellent choice for businesses that need HDMI output and hardware transcoding, as well as fast network performance and flexible upgrade options.

Lindsay Handmer

★★★★☆

\$339 | www.nzxt.com

Nzxt N7 B550

Look here if you love white themed builds.

Some boards focus on functionality, others overclocking, others value for money, and others still on bling. Nzxt's N7 B550 might be pigeon-holed into the latter category, but surprisingly, there's no RGB on the board itself. What it will do is appeal to users looking for a white-themed board that's ultra-clean and feature rich. Is the N7 B550 a board that clean-build purists should consider?

The N7 B550 is Nzxt's first AMD motherboard, though it has released several boards with Intel chipsets. The first thing you'll notice are the shrouds that cover most of the board. It creates a unique aesthetic; perhaps only the Gigabyte Vision-D compares to it, though that's a step up in price. Nzxt partnered with Asrock for the N7 B550, but it's not a clone though. It's actually one of the most feature-rich of all B550 motherboards, and at \$339 it offers surprisingly good value against strong competition from the big four.

The VRM system is capable. A 12+2 phase solution with 50a chokes will provide enough power to handle an overclocked 5950X. The VRM heatsink is indeed large with lots of finned surface area. In fact, it's one of the better B550 implementations all said.

The board is feature-packed, more so than many X570 boards. You get Wi-Fi 6E and 2.5G LAN, loads of USB ports – including ten on the back panel – ALC 1220 audio, and two M.2 slots. Sadly, these slots lack cooling. Also note that the bottom slot runs at PCIe 3.0 x2 only, so you'll be giving up some performance.

The rear I/O is packed with ports



Specifications

Nzxt N7 B550; AM4 Socket; Supports AMD Ryzen 3000 (Except 3000 G Series), 4000, and 5000 Series Desktop Processors; 2x M.2; 6x SATA; Up to 5x USB 3.2 Gen 2, 6x USB 3.1 Gen 1, 8x USB 2.0; AX210 Wi-Fi 6E; Realtek RTL8125BG 2.5G LAN; Realtek ALC1220 7.1 Channel HD Audio; ATX Form Factor.

and it's one of the best examples you'll see on any B550 board. There's the aforementioned 10 USB ports (though no USB 3.2 Gen 2x2) and a welcome HDMI 2.1 port for use with a 5000G-series APU. There's a standard set of audio ports including S/PDIF, BIOS clear and flash buttons. Wired networking is provided by a 2.5G Realtek RTL8125G controller.

The N7 B550 performed within a typical margin of error, as we expect from the now mature AM4 platform and BIOS. It performed well under both single threaded and multi-threaded tests. There are no surprises in gaming benchmarks either. If we had any concerns that we might see a lack of polish or inconsistency, we finished with none.

At \$339 the N7 is not a cheap board, but it's not alone there. It's a board that's primarily about its unique looks, something we wouldn't normally weigh too highly. If you're going for a

white build then there aren't many options. It has to do well in other areas though, and it does – mostly.

The poor M.2 implementation has to be considered, but otherwise its performance is solid. It's one of the few B550 boards with Wi-Fi 6E. Then there's that great USB complement. It takes punishment well, remaining cool under a heavy load. All in all the N7 B550 is a successful first AMD entry for Nzxt. With the right partnering components it's a great choice for an ultra-clean white-themed build. If you want fast Wi-Fi and you don't need to run heaps of drives, then the Nzxt N7 is well worth a look.

If looks are near the top of your list, this feature rich board could be for you.

Chris Szewczyk

★★★★☆

	Asrock X570S PG Riplide	Asrock B550 Taichi Razer Edition	NZXT N7 B550	Gigabyte X570S Aorus Master
X264 v5.0 Video Encoding - Pass 2 Avg FPS	51.98	52.42	52.78	53.08
Cinebench 20 - Multi thread Score	5,933	6,013	6,068	6,123
Cinebench 20 - Single thread Score	610	615	620	612
Blender 2.93 BMW Render - Time (seconds) (lower is better)	162.7	162.1	161.7	159.7
3DMark TimeSpy Extreme - Overall score	8,251	8,238	8,182	8,240
Civilization VI - 1080p, Ultra, DX12, Avg FPS	254	252	257	257
Civilization VI - 1080p, Ultra, DX12, Min FPS	189	185	175	178
Civilization VI - 1080p, Ultra, DX12, AI Turn Time	6.47	6.56	6.49	6.50

\$180 | corsair.com

Corsair RM850x (2021)

The Corsair RM850x is the new leader in the 850W Gold category.

It is tough to upgrade something that's already quite good. But Corsair managed to do so with the RM850x power supply, improving the efficiency at light loads, adding one more EPS connector, and using a top-notch magnetic levitation fan.

Corsair's RMx line is among the most popular in today's mid-segment PSU market, so updating was a daunting task. The use of a magnetic levitation fan is a great asset. The rifle bearing used in the previous generation RMx line was good, but there is no comparison with the ML fan that the new units utilise; Rifle and fluid dynamic bearings cannot cope with high operating temperatures. The only problem is the more aggressive fan profile, but updates from Corsair mean the new RM850x batches have lower average noise output than the initial production units.

The RM850x (2021) is the strongest member of the line, with enough power to handle a strong gaming system or a video editing workstation. To support the ultra-high-end mainboard, Corsair equipped it with three EPS connectors, something that's hard to find in today's market, even in stronger PSUs. The fully modular cable design is a must in this price range, and the same goes for the ten-year warranty, from the moment all competing offerings are supported by equally long warranty periods.

The build quality is good overall. Corsair used Japanese capacitors on both primary and secondary sides, and

Good solid engineering and quality components make the RM850x a reliable PSU choice.



known manufacturers provide the FETs. The magnetic levitation fan is among the notable changes in the new RMx units. It isn't as quiet as the rifle bearing fan that the older RMx units use, but it is far more reliable, especially at high operating temperature.

It can't be easy to upgrade a platform that was already among the best in the Gold efficiency category, but Corsair managed to do it. The new Corsair RM850x achieves higher overall

performance than its predecessor thanks to its amazing ripple suppression, tighter load regulation and higher efficiency, especially at light loads.

The only sections where the old RM850x prevails are transient response at 3.3V, which is not of great importance, and noise output because of the more aggressive fan speed profile and the new ML fan of the new unit. Despite the increased overall noise output, we still prefer the new ML fan because it is super reliable even under high operating temperatures.

The competition in the 850W Gold efficiency category is fierce but the new Corsair RM850x achieves first place in our overall performance chart, with the Super Flower Leadex III unit following. The latter has been replaced by the Leadex V model, which we haven't received yet, for review. Other notable mentions in this category are the XPG Core Reactor 850W, the Cooler Master V850 Gold V2, and the Corsair RM850 which has a lower price tag than the RM850x.



Corsair managed to improve the already great RM850x, offering even higher performance and a magnetic levitation fan. **Aris Mpitzopoulos**

★★★★☆



US\$1,599 | au.msi.com

MSI Optix MPG321UR

Is MSI's new gaming monitor all about the Optix, or is it a new benchmark for no-compromise gaming?

High resolution, high refresh gaming has been a bit of a pipe dream until now, but with two 4K 144Hz monitors in this issue we can officially say this ultimate gaming viewing experience is finally here to stay. The MSI Optix MPG321UR is the flagship monitor for the company this year and based on the long list of top end specs there's a lot to like. It's a little more expensive than Asus' TUF Gaming Monitor VG28UQL1A (p35), but it's also bigger, brighter and has a more impressive colour gamut, which definitely justifies the price bump.

At 32-inches the Optix MPG321UR is huge, so it won't have any issues displaying two, or even three, windows side-by-side. The 3,840 by 2,160 pixel resolution means that there won't be any pixelation across this generous screen, making it easy to work on and delivering an amazing gaming experience. This is about the biggest monitor that you'd really consider having on your desk, but this surplus size means it's a great device for plugging a next gen console into if you'd prefer to do some armchair gaming. The HDMI 2.1 input means you'll be able to run console games at their peak 4K 120Hz output settings without needing to nab a new TV.

Specifications

32-inch IPS display at 3840 x 2160 pixel resolution (16:9); 144Hz refresh rate; <1ms response rate (GTG); G-Sync; matte finish; 400nit typical brightness, 600 nit (peak); 1000:1 contrast ratio; 10-bit colour, Vesa HDR 600, 97% DCI-P3, 143% sRGB; 72.7 x 48.2 x 25.2cm; 10.1kg.

In addition to being able to run this monitor at its full 144Hz refresh rate over a DisplayPort 1.4 or HDMI 2.1 inputs, PC gamers will also get the benefit of G-Sync compatibility to eliminate screen tearing and other unwanted artifacts for anyone with a Nvidia GPU. Add to this, a professional-level sub 1ms GTG response rate and this high resolution screen is going to make gaming feel snappy and responsive, whilst still running at the highest quality possible.

The Optix MPG321UR takes screen brightness to the next level by offering a display with a 600nit peak brightness, allowing it to achieve Vesa HDR 600 certification. While this isn't quite the 1000nit minimum needed on a TV to achieve HDR certification, it does go a long way to making it a great looking option when you're on the couch. Combine this with the 97 percent DCI-P3 colour reproduction capabilities and you have an amazingly vibrant screen that's almost accurate enough to be used for professional colour grading purposes.

In addition to a handful of on-screen gaming enhancements like crosshairs and scope filters, the monitor includes a number of KVM USB 3.0 ports that allow you to plug in multiple devices and control them with a single controller or peripheral.

We do have to mention that some of the gaming viewing presets (particularly the racing mode) were not well-calibrated and made the colours look way more cartoonish than they needed to be; but if you can be bothered to customise these then the screen is good enough to handle how you'll want it to look. The only other limitation is the giant square base isn't particularly stylish or even overly stable on the front edge.

Unfortunately the high price tag combined with imperfect gaming and colour presets hold it back from its full potential. Nevertheless, MSI's Optix is a generous combination of high resolution, fast and vibrant gaming that is sure to offer impressive improvements to anyone's setup.

The 3,840 by 2,160 pixel resolution means that there won't be any pixelation across this generous screen, making it easy to work on and delivering an amazing gaming experience.

The holy grail of fast, high resolution gaming with a vivid colour profile, though could be a little cheaper. **Joel Burgess**

★★★★★



\$965 | asus.com/au

Asus TUF Gaming Monitor VG28UQL1A

A 4K gaming monitor that hits 144Hz and isn't too expensive.

The cost of high frame rate and high resolution gaming monitors has come down a lot in price over the last couple of years, but gamers are still generally required to choose between these two features. Since both high resolution gameplay and ultra-fast refresh rates seriously stress modern GPUs, it has historically made sense to focus on one or the other, but for those with cash to splash there haven't been many no-compromise options if they did want something with both features. The TUF Gaming Monitor from Asus has been designed to fill this gap in the market, and it isn't even as expensive as you might think.

This generous 28-inch 16 by 9 display offers a large viewing space with minimal bezels, which is sure to impress even the most selective customers. While it is primarily designed as a gaming screen the 3,840 x 2,160 pixel display is sharp enough to make it a great work monitor as well. The all black frame and monitor stand mean it won't even look out of place in the office.

While it might offer UHD resolutions this 4K IPS display also has a 144Hz refresh rate and a 1ms GTG response rate. Sure, there are higher refresh rates around, but when a Nvidia 3090 GPU

Specifications

28-inch IPS display at 3840 x 2160 pixel resolution in 16 by 9 format; 144Hz refresh rate, 1ms response time (GTG); 300nit typical brightness; 1000:1 typical contrast ratio; 10-bit colour, HDR10, 90% DCI-P3; DP 1.4 x 1, HDMI 2.1 x 2, HDMI 2.0 x 2, USB, 3.5mm headphone jack; 2 x 2W speakers; 64 x 54 x 21.4cm; 6.89kg.

isn't able to get much over 100fps running games in 4K, this is as high-end as anyone could really utilise right now. And while the refresh rate might be outpaced, a 1ms response rate is as good as it gets, so this screen is more than adequate for professional level gaming.

If you'd rather the convenience of a next-gen console then you can connect the VG28UQL1A via HDMI 2.1 for low-latency 4K gaming at up to 120Hz. The screen even offers variable refresh rate so it'll automatically sync with your console when you need it to.

This gaming monitor also includes official compatibility with both Nvidia's G-Sync technology and AMD FreeSync Premium, so you'll be able to get a tear-free gaming experience whatever your GPU allegiance is. Unfortunately this isn't the highest tier of AMD's FreeSync tech, which means that playing in HDR modes might introduce some latency at higher framerates. This isn't that critical but it is a little disappointing considering this is a display that is intended to deliver a no-compromise

gaming experience.

The TUF Gaming VG28UQL1A's 300 nit typical brightness and 1000:1 contrast is ample for the average desk setup and it's been fitted with 10-bit colour that meets VESA's DisplayHDR 400 specifications. This means games will look vibrant, and when you combine it with the high resolution it'll enhance the clarity and nuance of games to look truly incredible. While it's vibrant for gaming and will look great for work and media, it doesn't quite have the colour accuracy to do any professional video work, since it only reproduces about 90 percent of the DCI-P3 colour space.

Asus fits out its gaming monitors with a suite of gaming features like Variable Overdrive and Extreme Low Motion Blur Sync to remove some of the visual artefacts that are pretty obvious to the trained gamer. This screen's also has the Display Widget Lite software, which will allow you to tweak settings from your PC, and a suite of Game Plus options for on-screen gaming features like FPS counters and screen generated crosshairs.

This gaming monitor also includes official compatibility with both Nvidia's G-Sync technology and AMD FreeSync Premium, so you'll be able to get a tear free gaming experience whatever your GPU allegiance is.

A fast high res gaming screen for a future proofed next-gen gaming experience.

Joel Burgess

★★★★★



\$659 | rog.asus.com

Asus ROG Strix XG16AHPE

A fast portable gaming display with an abundance of bells and whistles.

With the anticipated arrival of game streaming services like Google Stadia and Nvidia's GeForce Now not too far off in Australia, the prospect of running demanding computer games on devices like smartphones and ultrabooks is almost a reality. While playing triple-A PC titles on a smartphone will undoubtedly be incredible, you still can't beat playing games on a bigger screen, but Asus' latest portable monitor might mean you can get the best of both worlds.

Ideally you'd use the ROG Strix XG 16 Portable monitor with Asus' very own gaming phone – the ROG Phone 3 – but it'll work with any smartphone with a USB Type-C socket. Currently this means you can play your favourite Play Store games on a 15.6-inch IPS display at Full HD resolution. If you've bought a Samsung, Asus, Xiaomi, Oppo or Motorola phone since 2019 there's a good chance it'll be capable of running at 90, 120 or 144Hz to give you a smoother gaming experience. The XG16AHPE is capable of running at up to 144Hz so when game streaming does arrive, you'll be able to push these framerates to the limits of your phone, since all the processing is done off site. The only other limitation here is the speed of your internet (or phone data) connection.

Specifications

15.6-inch IPS LED display at 1920 x 1080 pixel resolution (16 by 9); 144Hz refresh rate; 3ms GTG response time; Nvidia G-Sync compatible; matte finish; 300 nit typical brightness; 800:1 contrast ratio; 2 x 1W speakers; 2 x USB Type-C, 1 x micro HDMI, 3.5mm headphone jack; 900g (screen only).

The screen even includes adaptive G-sync technology, which will be great if you're connecting to a laptop to prevent any screen tearing or unwanted artifacts, but we're not sure how useful it'll be when streaming games, since the GPU isn't connected directly to the screen. It's also got a 3ms GTG response rate. This isn't the biggest factor in overall system lag when you're streaming, but it will at least help to make games feel as responsive as they can be.

Included is a 7800mAh battery that can power the screen for up to three hours of gaming at 1080p 144Hz. The 300nit brightness means that this battery estimate is a fair reflection of the timespan you can expect since you'll only need to have it set to about 50 percent for good quality daytime viewing. While battery life here is solid and you can extend this indefinitely if you are close enough to plug it in somewhere, though we were a little disappointed that there was no possibility to provide passthrough power to a smartphone that's plugged into it. Sadly smartphones running games

aren't going to last long and without some kind of third party dock since the screen can't charge your phone, even when it's plugged into power.

The screen does have a pair of 1W speakers and while they are not overly powerful they will at least magnify the sound offered on many smartphones. It's also got a suite of gaming technologies that can be accessed through the menus. Overdrive (for ghosting), AdaptiveSync, on-screen HUD items, game visual presets, and shadow boost technologies provide a range of gaming features that'll help you push your capabilities to the limit.

If that wasn't enough, the ROG Strix XG 16 even throws in a nifty travel case and a tripod stand that allows you to get the angle and height of your screen much better than the kickstands can offer. At \$659 it's not the cheapest portable screen around, but considering all the advanced gaming features, it's not unreasonable.

If you've bought a Samsung, Asus, Xiaomi, Oppo or Motorola phone since 2019 there's a good chance it'll be capable of running at 90, 120 or 144Hz to give you a smoother gaming experience.

A portable Full HD gaming screen with a good battery and a fast bright screen.

Joel Burgess

★★★★☆



\$649 | lg.com

LG UltraGear Ergo 27GN880-B

An ergo-armed work-play curiosity.

A PC monitor that pleases both gamers and productivity peeps? Sounds like a stretch, but that's the new LG UltraGear Ergo 27GN880-B's basic proposition.

The gaming half of the equation is covered by 144Hz of Nano IPS panel tech. LG claims it's good for 1ms response times. That's courtesy of the grey-to-grey metric, not the trickier MPRT measure, which can flatter to deceive regarding the subjective experience of pixel speed.

Support for both AMD FreeSync and Nvidia G-Sync flavours of adaptive refresh is also included. Combine all that with the popular 27-inch form factor and 1440p native resolution (2560x1440 pixels), and you have a solid base for a gaming panel. There are panels with more pixels. There are monitors with higher refresh. But that 144Hz, 27-inch, 1440p, 1ms combo from an IPS panel is a real-world sweet spot. Few gamers will truly need more.

As for productivity, the most obvious element is the name. This Ergo monitor sports an asymmetric stand that clamps to a wide range of desktops measuring up to 3.5 inches thick. It offers a really wide range of adjustment, including 280 degrees of swivel, 18cm of extend and

Specifications

Panel Size: 27-inch; Panel Type: Nano IPS; Resolution: 2560x1440; Brightness: 350 nits; Colour Coverage: 98 percent DCI-P3; Refresh: 144Hz; Contrast: 1,000:1; Response: 1ms GtG; Adaptive Refresh: FreeSync, G-Sync; Inputs: 2x HDMI, 1x DisplayPort.

retract, plus pivot into portrait mode. You basically just grab the thing and position it where you want. It's pretty neat. The stand includes some clever cable management, too, by routing everything through the main arm, down to the base. Perfect if desk space is at a premium.

Speaking of cables and connections, arguably the LG 27GN880-B's most obvious shortcoming is the absence of USB Type-C. That's a pity. Being able to hook up a laptop via a single cable would really suit this monitor's overall vibe.

Still, the LG UltraGear Ergo 27GN880-B clocks in with some pretty impressive colour fidelity, with 98 percent coverage of the DCI-P3 gamut. The sole snag is that sRGB is the only colour space preset in the OSD. Anyway, while the LG 27GN880-B isn't an out-and-out pro display designed for high-end workflows, such as mastering video, it is a plausible panel for light content creation.

It's also a very nice gaming panel. Most impressive is the speed and response. LG

includes three levels of user-configurable pixel overdrive in the OSD menu. In truth, the fastest option is a bit of a mess and suffers from obvious overshoot. But the middle setting is super-sharp. Only the very quickest TN panels offer better response, at the cost of contrast, viewing and colour accuracy.

Slightly less impressive is the overall punch. At 350 nits, it's not dingy, but in this age of 1,000-nit HDR eye-scorchers, the experience is conspicuously SDR. For the record, HDR10 signal decoding is supported. And not only does HDR content look decent, SDR content is also handled well in HDR mode. But this is not a true HDR panel. There's no local dimming and peak brightness is nowhere near what's required for sufficient dynamic range.

All told, the LG UltraGear Ergo is an appealing curio. It's more convincing as a gaming panel than a productivity tool, for sure. But if you're looking for a monitor that can also turn its hand to more serious affairs, as well as improve the ergonomics of your desk space, stick it at the top of your shortlist.

Support for both AMD FreeSync and Nvidia G-Sync flavours of adaptive refresh is also included. Combine all that with the popular 27-inch form factor and 1440p native resolution (2560x1440 pixels), and you have a solid base for a gaming panel.

Speedy IPS panel and super ergonomics, good colour accuracy but no USB-C connectivity.

Jeremy Laird

★★★★★



\$599 | [asus.com](https://www.asus.com)

Asus ProArt Display 14 PA148CTV

A precise on-the-go display for creative professionals.

Every professional photographer has their own particular workflow, but there's always something you could add to your kit to improve it a little – or in this case, maybe a lot. Asus's ProArt Display 14 is a colour-accurate portable FullHD monitor that'll connect directly to your camera so you can check images on the fly to ensure you're not missing the shots you need.

The PA148CTV can be mounted directly to a tripod via the thread at the bottom centre of the screen or positioned on a table with the rear kickstand so you can position it at a convenient height, exactly where you need it. This can then be connected to a camera via the included micro HDMI cable or the two USB Type-C sockets. While the former here will carry visuals and controls from your camera across to the display, the USB-C

Specifications

14-inch IPS display at 1920 by 1080 pixels (16 by 9); 8-bit colour; 157.35 PPI; 100% sRGB, 100%Rec. 709; 60Hz refresh rate; 5ms GTG response time; 300 nit brightness; 700:1 contrast; micro HDMI x 1, USB-C x 2; 2.5kg.

connection is also capable of powering the device, as long as whatever you connect it to can output 10W of power. Seeing as most of the time you're going to be connecting it to your camera there's an additional USB-C port so you can run power concurrently.

Unfortunately there's no battery in this one so you'll have to ensure you're able to hook it up to permanent power. It's a little disappointing to not have the additional flexibility provided by a battery, but there are legitimate trade-offs to weigh up here. Considering both the additional expense of a battery and that it's intended to be used by professionals on-set, it's generally

going to be in demand for much longer periods than any battery would last – especially with the brightness cranked up, so we understand the omission.

This display has been calibrated to be suitable for any professional sRGB colour work so you can trust that when you eye it in the studio you won't get any nasty surprises when you get back to the editing room. Unfortunately for anyone working in higher resolutions or HDR colour spaces you'll only get an approximation using the DCI-P3 setting since it's only capable of handling 8-bit colour.

Asus has included a dial on the back of the unit that is primarily designed to access the menu system, but which has been tweaked to interact with menus in Adobe's Creative Suite. When combined with touch screen functionality this control wheel makes basic editing on the go fast and intuitive enough to work into your workflow if the need arises.

The device's touchscreen compatibility allows you to interact with photos directly on the screen. The 10-point touch functionality will only be usable by certain camera and PC operating systems so check your camera specs if touchscreen functionality is a must have feature.



Does anyone need a 14-inch professional display? Asus thinks so, and maybe it's just right for you.

A great portable display that offers a precise colour setting. **Joel Burgess**

★★★★★

\$TBA | gskill.com

G.Skill Z5i

A case of two halves.

The G.Skill Z5i is one of the best-looking cases we've seen in the last year or so. Its hinged curved tempered glass panels allude to the interior with subtlety and grace. The front I/O is a smooth sheet of brushed aluminium, bound into the rest of the aluminium frame, and littered with triangular perforations that run around and through the heart of the case itself, ensuring that airflow is plentiful. On top is a simple yet effective mesh vent, while the base is a surprisingly premium plastic composite, with integrated underglow RGB lighting, and G.Skill logo cutout, all of which is controllable via your motherboard.

There's no denying that the Z5i is a bold design, the lines are sharp, the aesthetic exceptionally clean, and its premium materials and overall standing look to be near perfect. But does form come before function? Is it just a fraction too much for a company more at home building DRAM than designing the next showstopper?

Inside, the case has a tri-chamber design. The left-hand side houses the motherboard and your SFX power supply, the right-hand side, the graphics card, and at the rear of the unit lies an unfiltered perforated area, where you can mount up to a 280mm AIO, or two 140mm fans along with some 2.5-inch drives. A quick hop over to the Z5i's

product page showcases numerous animated videos detailing just how clean your build will look once complete inside. But there's a problem, a big one, and it's something that all those videos carefully sidestep: cable management.

There are a few cutouts between that centre panel separating the right and left compartments, allowing you to route cables from the motherboard to the GPU side of things, and you can hide some cables coming from the power supply itself, but that's about it. You're

left to tuck things away around the back on your own.

That means hiding cables behind the graphics card or strapping them to the rear area near the cooler out of sight, and you just end up tying them to the frame in any way you can. This is a case that demands short custom cables at a minimum, and even then, you're still going to end up in a bind. The cable management situation is so difficult to deal with, it completely alters how you build the PC entirely. It's not something you can leave to the end, and tidy up after. In our build this issue (page 80), we ended up cable tying everything down to the main frame that we could, using spare cable ties that we had from previous builds, not ones included with the case itself. After that, we installed the AIO, before doing some more cable management, before finally finishing up installing the GPU. There's no wiggle room here whatsoever, and that's a shame.

This is one of the best-looking cases we've seen for some time. Its cooling is top-notch (surprisingly), and from a material standpoint, it's fantastic. But, if you can't tick that box of ensuring your PC builder can easily manage their cables, then the design needs to go back to the drawing board.

Incredible aesthetic and impressive materials but the design ignores good cable management. **Zak Storey**

★★★★☆



Poor cable management facilities let this otherwise excellent and interesting new case down.





\$340 | elgato.com

Elgato Facecam

A streamer's right-hand man?

Webcams have become an essential part of day-to-day life for millions of people over the past year or so, but many are now ditching their built-in cams for more premium peripherals. The Facecam is Elgato's first webcam, so should people turn their attention towards this cam and add it to their setup?

Straight out the box, we have to say this is a chunky cam. This isn't necessarily the worst thing as it houses a pretty big-looking lens, which is the most important part of a camera, right? Included with the Facecam is a little lens cover which is always a nice addition to the package. Nothing says privacy like physically blocking out the camera. Also, the cam comes with a detachable L mount that is quarter-inch thread compatible. This pairs wonderfully with Elgato's Master Mount

System too if mounting it on top of your monitor isn't the best setup for you.

Setup is a simple process, and while you can just plug and play, we would recommend getting Elgato's Camera Hub application to tweak some of the camera's settings. Conveniently, as soon as we plugged it in, the video quality looked great. Considering the testing environment wasn't particularly well-lit, the Facecam did a great job at maintaining crystal clear clarity and making sure the image was bright but not over-exposed.

The lens used in the Facecam is Elgato's prime F2.4 lens, with a 22mm focal length. It also features Sony's STARVIS CMOS sensor, which is pretty good going. The 82° field of view will cover most of your room and because the Facecam is limited to Full HD 1080p, unfortunately, it

isn't a 4K cam. However, if you use the Facecam mainly for video calling, that should still be sharp enough.

If your image isn't looking quite right, the Camera Hub app is a decent place to fix some settings. Thankfully, like the Facecam, the app is easy to set up and simple to understand. Once inside the app, you will be greeted by a preview panel and the tools on the left-hand side of the screen. These are all pretty generic settings, but it makes it easy to tweak different elements and get your image looking its best.

For its first attempt at a physical webcam, Elgato has done a grand job. The main thing to point out is that the image quality is clear and looks buttery smooth at 60fps even if the lighting isn't the best. With no compression and low latency, it makes for a detailed image. Unfortunately, there is no HDR which is a shame, however, colours still look deep and you can alter the white balance and saturation settings in the Camera Hub. Other negatives worth mentioning are that the build quality and design aren't the greatest, there is no built-in microphone, and the mount isn't the most secure. But if you can look past this and the slightly pricey cost, the Elgato Facecam is a capable camera to add to your setup.



If you want more than your laptop's built-in cam can deliver, the Elgato is a good premium option.

Wonderful Full HD clarity and smooth 60fps, great low-light capabilities, but no 4k, auto-focus or mic. **Sam Lewis**

★★★★☆

\$999 (128GB), \$1,199 (256GB) | asus.com.au

Asus Zenfone 8

The Zenfone 8 is a great small phone with compromises.

The Asus Zenfone 8 represents a paradigm shift for a flagship phone – not to higher prices and more features, but to greater affordability, with essential specs and strong cameras. It's the kind of device phone brands like OnePlus used to release, and it's just as welcome.

Greater affordability inevitably comes with compromises though, and the Zenfone 8 misses out on the feature that made its predecessor stand out: its flip camera, which enabled the Zenfone 7 to take rear-facing and selfie photos with the same set of lenses.

You can still get this novel camera functionality, but only in a larger specialty version of the phone – the aptly-named Zenfone 8 Flip, which will be a limited release, cost more, and come in a single RAM and storage configuration.

Asus is envisioning the Zenfone 8 to be the standard version of the phone, with high-end specs in a variety of configurations – a top-tier Snapdragon 888 chipset and up to 16GB of RAM and 256GB of storage – at a very competitive price. That means consumers comparing the Zenfone 8 to other flagship phones will have to get on board with other compromises Asus has made – there are only two rear cameras (there's no telephoto lens), and this is a smaller phone with an under-6-inch screen.

Those two cameras are impressive enough – there's a 64MP main shooter and 12MP ultrawide camera, and a front-facing camera in a punch-hole. As we've seen with previous Asus phones, these cameras perform well in good light, although they lag behind other flagship phones in low-light and night photography.

As mentioned, Asus' new flagship phone is a small device, with design considerations tailored to one-handed use that include a tall and narrow design and refined one-handed interface mode. Its size makes it something of a rarity among phones with flagship specs, rivalling the iPhone 12 mini and lower-specced Google Pixel 5 in what it offers.

Otherwise the phone inherits a lot from its predecessor and other Asus



Asus' new flagship phone is a small device, with design considerations tailored to one-handed use that include a tall and narrow design and refined one-handed interface mode. Its size makes it something of a rarity among phones with flagship specs, rivalling the iPhone 12 mini and lower-specced Google Pixel 5 in what it offers.

phones, from the 120Hz screen refresh rate and ZenUI OS overlay to gaming modes and a 3.5mm headphone jack. And while its 4,000mAh battery capacity won't turn heads, it's still enough to keep the phone going through a day.

All in all, that makes the Zenfone 8 a compelling and powerful phone that's smaller than a lot of the competition – which may suit some consumers more than others who want more screen area to watch media or play games. The Zenfone 8 Flip does have a bigger 6.67-inch display, plus the

forementioned flip camera capability, although as mentioned it costs more, and availability is limited.

The Zenfone 8 is also available in configurations up to 16GB of RAM and 256GB of storage. The Zenfone 8 comes in two colours: a matte Obsidian Black and silver-framed, white-coloured Horizon Silver.

A solid flagship phone at a sub-flagship price, though inevitably there are compromises.

David Lumb

★★★★★



\$350 | corsair.com

Corsair 7000D Airflow

More cooling! More cooling!

Corsair is going big, with a new full-tower PC case. The 7000D Airflow is the case built to house chunky cooling solutions, and it certainly lives up to its name.

Let's start by talking about fans and radiators. The 7000D comes with three non-RGB 140mm fans, but there's space for plenty more – the front can handle up to four 120mm fans (or three 140mm), and the same goes for the upright cooling bracket that sits behind the cable cover plate on one side. At the top of the case, there's a removable rail bracket that can support 420mm of radiator space, and there's naturally a vent for a single pre-installed 140mm fan at the rear.

Using all these concurrently isn't quite an option, as large radiators mounted to the front and top can encroach on each other, but there's undeniably space for plenty of workstation-level cooling here. The front and top panels are highly

perforated steel to allow for superior airflow, with magnetic dust filters and hinged side panels, one of which is a full glass window. Taking the 7000D apart to build in is a relatively painless process.

The massive 80-litre interior allows for some chunky builds, with extended ATX motherboard support and enough GPU clearance to handle the biggest RTX 3000-series cards. A windowed PSU shroud runs along the bottom of the case, allowing you to view your power supply while also concealing a pair of drive cages, each of which can hold three HDDs or SSDs.

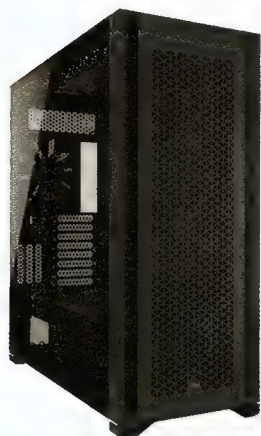
Elsewhere, we've got four dedicated mounting plates for 2.5-inch SSDs, and a variety of plastic and metal contraptions for routing and concealing cables. The rear of the motherboard plate actually hides behind a second, smaller hinged metal panel beneath the vented side panel, ensuring a tidy appearance

regardless of how your cable management skills are.

Even with all the extras removed, this is still a seriously heavy case. With its full-tower form factor comprising over 18kg of steel, plastic, and tempered glass, the 7000D can be a nightmare to move around, especially when building in it. The build quality here is superb, though, with every part feeling sturdy and well crafted.

The front I/O is very well equipped, offering four USB-A 3.0 ports along with USB-C and a headphone jack. There aren't any RGB control buttons to be found here; the 7000D favours a more muted appearance, as evidenced by the dark tint on the window panels. It's hard to deny that this is one of Corsair's best-looking cases, both in the black model we're reviewing and its vivid white counterpart.

This isn't a case for the workaday PC-builder, with its gargantuan frame and roomy, feature-packed interior. But it's certainly an excellent choice for anyone who needs a large-scale build, whether that's a central system packed with NAS drives or a supercharged editing rig. With smart design choices that make building easy (barring its overall bulk), the 7000D is one of the best full-tower cases we've seen in years.



The massive 80-litre interior allows for some chunky builds, with extended ATX motherboard support and enough GPU clearance to handle the biggest RTX 3000-series cards. A windowed PSU shroud runs along the bottom of the case, allowing you to view your power supply while also concealing a pair of drive cages, each of which can hold three HDDs or SSDs.

Top-notch build quality, loads of space for drives and cooling plus good front I/O – though as heavy as it gets. **Christian Guyton**

★★★★★



\$199 | rog.asus.com/au

Asus ROG Gladius III Wireless

Asus cuts the cord but the Gladius is still held back.

Asus's ROG Gladius gaming mice have been kicking about for over half a decade now, with each subsequent iteration improving slightly – and only slightly – on the previous model. Unsurprisingly, this is still the case here, with the Gladius III Wireless removing the power cable but ultimately doing little to differentiate itself from the standard Gladius III.

Is that such a bad thing? This is still a well-made device that ticks all the standard boxes for a gaming mouse. It features three-zone RGB lighting (customisable via the Armory Crate software, or the lighting profile button on the underside) along with sturdy construction and swappable Omron switches for the two main clicker buttons, thanks to Asus's push-socket design. This allows you to switch over to quieter switches, or merely extend the mouse's lifespan with replacement parts.

The default Omron switches offer a firm click, as do the two thumb buttons on the right-hand side. Sorry, southpaws; this is a right-handed

mouse with no options for physical customisation. The scroll wheel is translucent with a rubberised finish, which feels great for controlled scrolling. A dpi adjustment button sits behind the wheel, well-positioned to avoid accidental clicks.

Connectivity is tri-mode; Bluetooth, 2.4GHz, or wired. None of these modes generate any appreciable input latency, although we found the 2.4GHz more reliable than the Bluetooth. You need a USB-A port on your device for the included dongle, but the mouse has a slot for housing it on the underside so it's easy to take out and about. The plug-and-play functionality of the 2.4GHz mode is perfect for pairing with a gaming laptop.

In terms of general performance, the Gladius III Wireless does well. Battery life is great, with moderately better performance using the Bluetooth mode or by turning off the RGB lighting. A full charge lasted six days (about 48 hours of use) in 2.4GHz mode with the lighting on, which is certainly above average. The

optical sensor is a 19,000 dpi model, tuned up to 26,000 by Asus. In practical terms, the average gamer is unlikely to want much above 3,000, but high-dpi sensors have become the norm for gaming mice and this Gladius doesn't buck the trend.

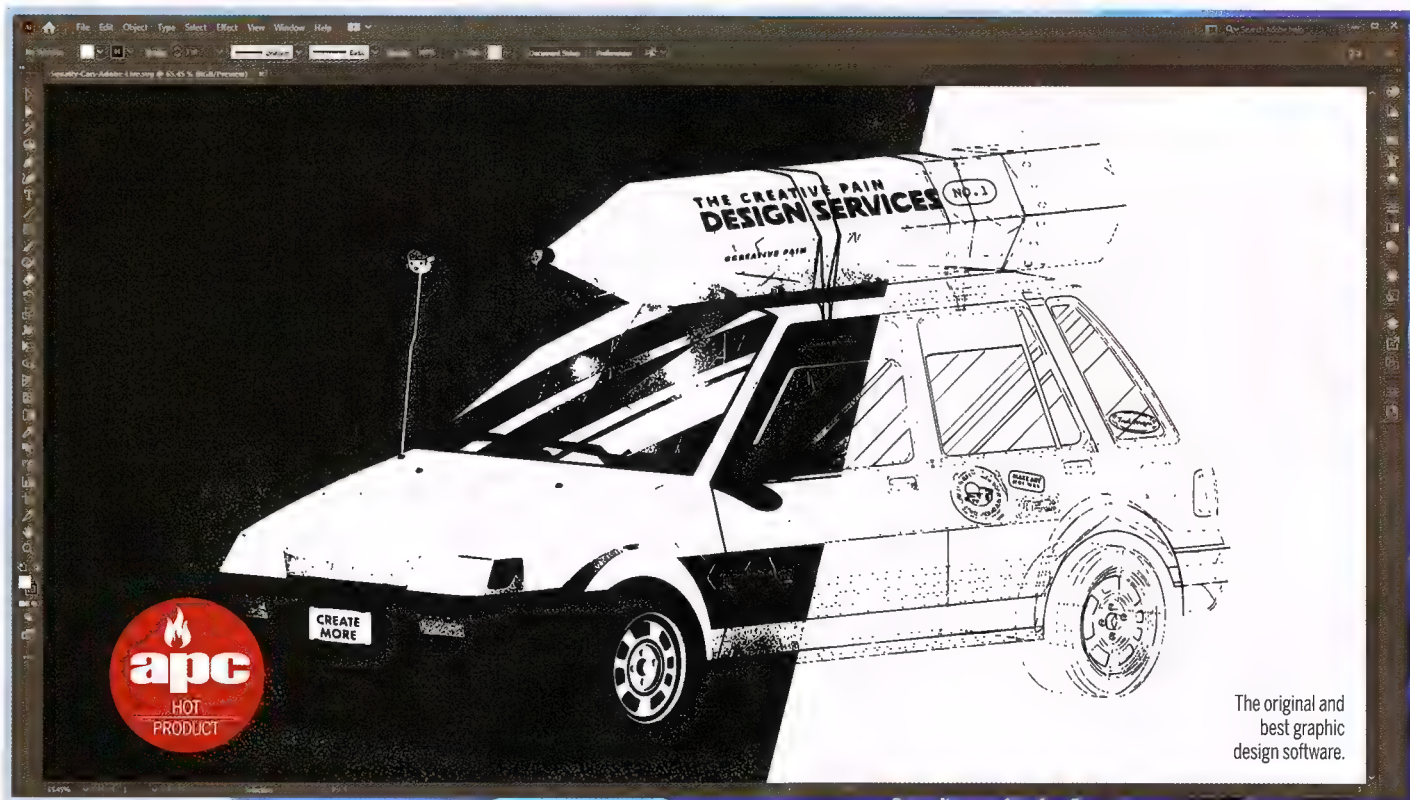
Lift-off distance is good, with input feeling snappy and responsive. Teflon feet on the base let the mouse glide easily over any surface, and a set of replacement feet are included should they become worn or damaged. Between that and the extra Omron switches, this feels like a long-life product.

Our biggest issue with this Gladius is that for the price, it doesn't set itself apart from the crowded gaming mouse market. That's not to say it's a bad product, but there are plenty of competitors in this price bracket that do more interesting things. If you're a palm-grip user looking for an ergonomic mouse for work and play, the Gladius III Wireless is a good shout. Otherwise, we recommend you do some comparisons to find the best mouse for you.

In terms of general performance, the Gladius III Wireless does well. Battery life is great, with moderately better performance using the Bluetooth mode or by turning off the RGB lighting. A full charge lasted six days (about 48 hours of use) in 2.4GHz mode with the lighting on, which is certainly above average.

Good connectivity options and swappable switches plus excellent battery life., but poor weight distribution and lacks unique features. **Christian Guyton**

★★★★☆



ADOBE ILLUSTRATOR From \$29.99 per month www.adobe.com AFFINITY DESIGNER \$84.99 www.affinity.serif.com

Adobe Illustrator vs. Affinity Designer

Can the design newbie knock Adobe off its perch?

Before we pit these two rivals against each other, let's take a step back in time to where it all began. The year is 1987, Adobe has just released its first piece of software called Illustrator for the Apple Macintosh. It was, and still is, a vector art and design software that by today's standards looks pretty darn basic. However, in the late 1980s, this piece of technology completely revolutionised the art of graphic design.

Before computerised work, creating a piece of design was a massive task and extremely time-consuming. Everything had to be done manually, including rulers and french curls, and typography was created letter by letter. One page of set type may even take a day or two to complete. You think making a mistake on a computer is a problem? Nowadays, you simply press Ctrl-Z to undo the error, but back then, a mistake in traditional design work could often mean starting all over again.

Illustrator was designed to prevent this from happening while being more efficient and pushing the boundaries of what could be done. The concept of a computer being able to draw for you introduced a whole new way of thinking to industries such as graphic design, marketing, and publishing. Illustrator eventually replaced Adobe's PostScript software, a page description language that was previously only usable by computer programmers. Illustrator was an application that made the process a whole lot smoother, allowing more accurate control over curves, shapes, and lines that you could see in front of you.

The pen tool was one of the first and most useful tools Illustrator had. It meant you could draw accurate curves, perfectly straight lines and also create infinite variations of shapes by drawing as many points as you wanted. These were the building blocks to every type of design you see today and that certainly

gives Illustrator some brownie points.

There have been lots of updates and new versions of Adobe's Illustrator since, but its purpose has never changed. It is engineered to be a graphic designer's best tool, used to create brilliant vector designs that allow you to make graphics, logos, icons, or typefaces that you can scale up and down without losing resolution. Illustrator also comes with specialised tools that help you create more complex designs to perfect your work.

Templates are another great feature, removing the need to create documents from scratch. There are templates for digital, print, web, and mobile, that support both CMYK and RGB colour spaces. Illustrator's custom workspaces can help you organise the UI exactly how you want it – that's the great thing about Illustrator, it's extremely adaptable. It also works with the rest of the Adobe Suite of programs, including Photoshop and InDesign.

But now we have a contender, in the shape of Affinity Designer. Serif also began in 1987 creating creative software for Windows, but later launched the

The concept of a computer being able to draw for you introduced a whole new way of thinking to industries such as graphic design, marketing, and publishing.



On the whole, both of these programs are excellent, offering great services to creative types, whether they use these programs for a hobby or take a more professional interest. Illustrator lends itself slightly more to profession

Affinity range of applications, the first of which was Affinity Designer, released in 2014. This application is aiming to set a new industry standard for graphic design, and with some decent awards in recent years, including winning Application Creator of the Year in the Windows Developer Awards 2018 and a five-star award from Editors Choice, it has become a real alternative to its illustrious rival.

Affinity Designer is a similar program to Illustrator – both applications offer the user a similar experience and both are used for the same end products. However, there are some areas where Affinity Designer beats Illustrator. One of the main benefits of Affinity is the lack of a subscription fee. A one-off payment of \$84.99 is far cheaper than paying a minimum of \$29.99 a month for Adobe Illustrator on an annual plan.

Illustrator hasn't always been subscription-based, however, it was brought under Adobe's Creative Cloud subscription service, which now costs \$76.99 per month for all of its programs. If you don't want to sign up for an annual contract, that's some pretty big bucks. Affinity takes the crown here on affordability, however, both programs

offer a trial service, so we'd recommend trying them before committing to a purchase.

Affinity is also a marginally easier piece of software to use. Its layout is cleaner, bolder, and more colourful, whereas Illustrator can be a little overwhelming, particularly for a new user. If you have used other Adobe products before, Illustrator's layout should be familiar, but approaching both programs as a new user, Affinity's product has a more organised layout by default. It's also a lot more fluid and visually speaking, benefits from running at 60fps. Due to this ease of use, Affinity could be more appealing to a newer audience, however, it doesn't have as many tools and features as Adobe's offering.

On the whole, both of these programs are excellent, offering great services to creative types, whether they use these programs for a hobby or take a more professional interest. Illustrator lends itself slightly more to professional usage. This comes down to its extensive history of use within the publishing and design industries, meaning that more people are accustomed to using this application.

Affinity Designer may appeal more to the beginner with an easier user experience and it opens the door for newer creatives to work digitally. With a cleaner and faster UI, it makes Illustrator look heavy and will certainly gain more traction because of this. Also, Affinity's subscription-less program gives it an edge over Illustrator when it comes to fresh artists and creatives looking to save a substantial amount of money per year.

They both have great qualities but in terms of professional usage and more features, Illustrator is worth that extra bit of patience to learn and use as it also ties in well with other Adobe programs. For an overall package and longevity purposes, Illustrator has the edge over Affinity design due to its extensive background and business hierarchy. Nevertheless, that's not to say that Affinity isn't an excellent product too.

Adobe Illustrator

Feature rich, revolutionised graphic design, a powerful program – but is subscription based.

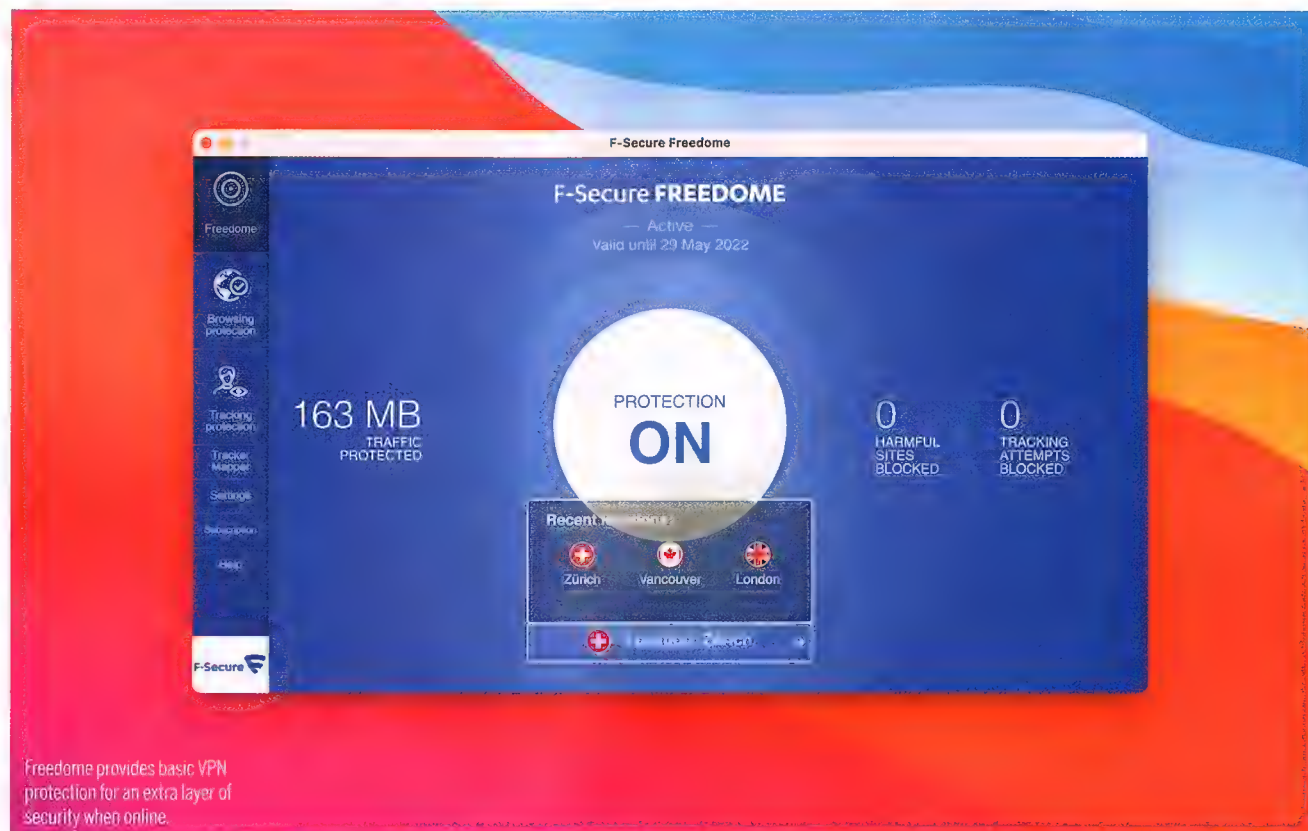
★★★★★

Affinity Designer

One-off purchase; easier to use, fast and responsive @60fps, vector and raster, but still not industry standard.

Sam Lewis

★★★★★



macOS 10.11 or later | US\$89.99/year (3 device); US\$109.99/year 3 devices | f-secure.com

F-Secure Total

Can this Finnish security product compete with the big boys?

Total is F-Secure's top-of-the-line security product for Mac, and comprises three products, which you install separately.

F-Secure Safe offers core antivirus protection, backed up with ransomware protection, browsing and banking protection, and parental controls. It's easy to install, and steps you through the process of giving the app the access it requires. The main interface is straightforward, but bare. Configuration is virtually non-existent – a stark contrast to the likes of Bitdefender and Norton. There are just two types of virus scan: full or 'choose what to scan'. Most

other controls are on/off with a handful of advanced controls buried in the app's entry under System Preferences. Parental controls offer a bit more tweaking, although even here you're limited to setting time and usage limits, plus web filters, for any other users of your Mac.

Total's 'bonus' tools are a password manager and VPN software. ID Protection protects passwords and other sensitive info – everything is double-encrypted behind your master password, but there's no additional security in the form of 2FA. The app also betrays its Windows focus by failing to provide a Safari add-on (Chrome and Firefox are supported). The omission is doubly strange given that Safe's browser protection component does integrate with Safari.

Similarly, Freedom VPN can't hold a candle to dedicated VPN services. On the upside, you can use it on your phone as well as your Mac to encrypt your internet connection when using public Wi-Fi networks, and it can also block tracking attempts via insecure HTTP traffic plus scan for malware, tracking cookies and other online threats. Weaknesses include restricting you to a choice of 28

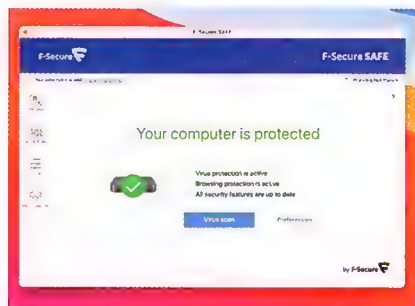
servers across 22 countries, with a focus on Europe and the Americas. Performance is noticeably affected too: Speedtest reported a 25-30 percent drop-off over our fibre connection when using Freedom. Nevertheless, it's competitively priced as part of Total, and is fine for occasional use, plus can be used to bypass geo-restrictions abroad too.

As a simple, set-it-and-forget-it solution Total does a reasonable job. However, Safe's current AV-Labs test scores of 5.5 out of 6 for both protection and performance reveal two key issues. The first is less-than-perfect protection – a 99.6 percent malware detection rate isn't bad, but four products (Norton, Trend, Bitdefender and avast) score 100 percent. And second, there's a noticeable – if not crippling – impact on accessing files and opening programs thanks to Safe's real-time scanner.

You could definitely do worse, but there are better options out there.

The ultimate example of 'meh': Total provides adequate protection, but you can do better. **Nick Peers**

★★★★☆



The F-Secure Safe element is a no-nonsense – and definitely no-frills – security application.



One of our favourite iOS features is the ability to use the camera as a scanner for things like .3i€SS Caras, receipts ana other pits and pieces. Genius Scan takes that idea and doesn't so much run with it as strap it to an express train. It's a fully-featured scanning app that

takes full advantage of your iPhone, iPad or iPod touch's high quality camera and processing

power,

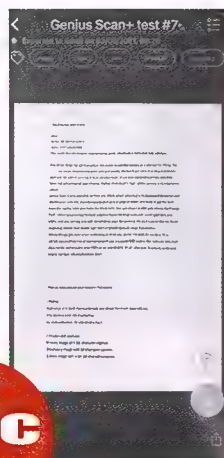
Genius Scan 6.0 is available for free and offers smart scanning with document detection and background removal, distortion correction and a range of filters and tools to get the best possible quality from your scanned document. You can export to PDF and create multi-page PDFs either by scanning multiple pages or by combining scans and existing photos and PDFs, and you can tag and add metadata to your documents. We particularly like the Batch Scanning feature that makes light work of grabbing multi-page documents.

Where things get even more interesting is when you go for the paid-for version. This introduces multiple cloud service support and a superb OCR engine that extracts text from documents and enables your PDFs to be searchable. It can also scan business cards and

create contact information from them.

*Please also include screenshots in the review.

Left: The OCR copes well with even very small text sizes.
Below: Once you've scanned a document, it's easy to create and use tags.



iOS 13 or later | \$12.99 | thegrizzlylabs.com

Genius Scan+

Fast scans and excellent OCR.

Genius Scan+ is a fully featured app that uses your iPhone, iPad, or iPod touch's camera and processing power to deliver scanning and text recognition.

Genius Scan+ offers smart scanning with document detection and background removal, distortion correction, and a range of filters and tools to get the best quality. You can export to PDF and create multi-page PDFs either by scanning multiple pages or by combining scans and existing photos and PDFs, and you can tag and add metadata. The Batch Scanning feature makes light work of grabbing documents.

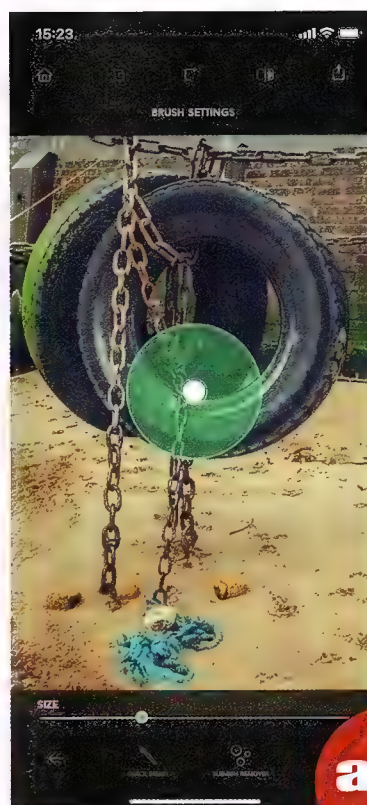
While a free version, named Genius Scan, offers many of the above features, Genius Scan+ adds multiple cloud service support and an OCR engine that extracts text from documents and enables PDFs to be searchable. It also enables you to protect your scans with Face ID.

The OCR works well and quickly even when the font sizes are fairly small. Complex layouts can be confusing and documents with thin fonts or light text require good lighting. Accuracy isn't quite 100 percent but it's close enough, and if you export your scans as text and then delete the originals you can store a lot of documents in very little space. Your export options are PDF, JPG and text, and you can share via email, cloud storage, Files, and even FTP.

Fast, flexible, and useful scanning with good OCR.

Carrie Marshall

★★★★★



Left: Smaller details can be removed – simply set the brush size.

Below: Object removal is performed by drawing with a brush or lasso.



iOS 12 or later | \$2.99 | adva-soft.com

TouchRetouch

One-touch object removal for pics.

TouchRetouch is an affordable app that aims to make object removal and repair simple. The Object Removal tool sets your brush size, and you can use a lasso tool and erase unwanted parts of the green mask. When you hit Go, the app analyses the area around your selection, and works out how to fill the mask and remove the object.

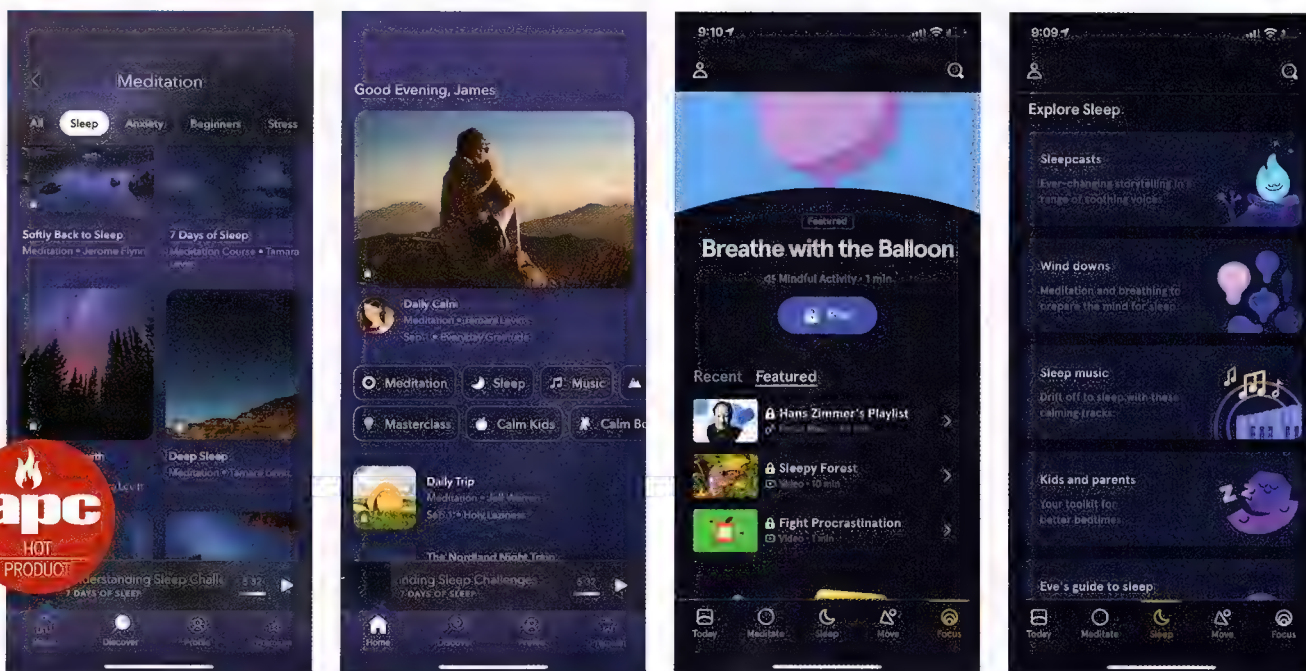
It is extremely effective. However, an object on a uniform background is easier to remove than something on a busy background. You are able to zoom in, which makes precise selection easier, and a before and after button is helpful. The larger the object you want to remove, or the more cluttered the image, the trickier it may be. The app does an impressive job and produces good results.

A Quick Repair tool works similarly but on blemishes and dust, rather than whole areas of content. There's also a Line Removal tool, where drawing over a line will remove it. Finally, a clone stamp tool lets you replicate sections of an image. Any retouching of this kind has to be done carefully and strokes that are too broad will not work well, but you can undo and try again. With a little care it's easy to remove unwanted elements with this app. Export options are good too, with solid format options for maintaining full resolution or shrinking down for email.

This is a highly effective and easy object removal tool for your photos.

Hollin Jones

★★★★★



Android | Free with IAP

Headspace

Look after yourself.

With over half the country in lockdown as I sit down to write this copy, it's difficult to find time to dedicate to self-care and mindfulness. Headspace offers a wide variety of both audio and video wellness content related to helping you sleep, as well as guided meditation, and exercise.

Unlike many other wellness apps, the focus with Headspace is on compassion and positivity – with sessions related to having difficult conversations, finding positive moments in tough times, or coping with anger and change.

The app is well designed, colourful, and breezy. It adapts to the content that you listen to and modifies a daily playlist based on the time of day, such as a meditation setting in the morning, a

focus playlist in the afternoon and a pre-sleep session at night. At best, Headspace doesn't overstay its welcome, giving you choice across a wide range of topics and sessions but doing a good job of curating them.

It should be noted though that Headspace is not a cheap application – while it is free to download, its standard pricing is quite a hefty \$20/month, although there are regular discounts on annual fees which tend to be a lot cheaper. I would note that if it wasn't for the sheer amount of daily refreshed and curated content – of which there is a lot – I would have probably not recommended it.

But with that cost it is hard to recommend it to everyone, particularly

when there are options that tend to be a little cheaper, albeit with less focus on curation and crafted daily experiences, but if you value a personalised approach to mindfulness and self-care via soundscapes and narrative experiences, it's hard to improve on Headspace.

I also took a quick look at a very similar app – Calm – but found that Headspace provided a much more individual experience with its daily functions, as well as a wider and more regularly updated schedule of meditation programs. I particularly enjoyed the Group Meditation function, which provides a regular daily “virtual” group meditation at 5pm. JAMES PINNELL

★★★★★

Android | Free with IAP

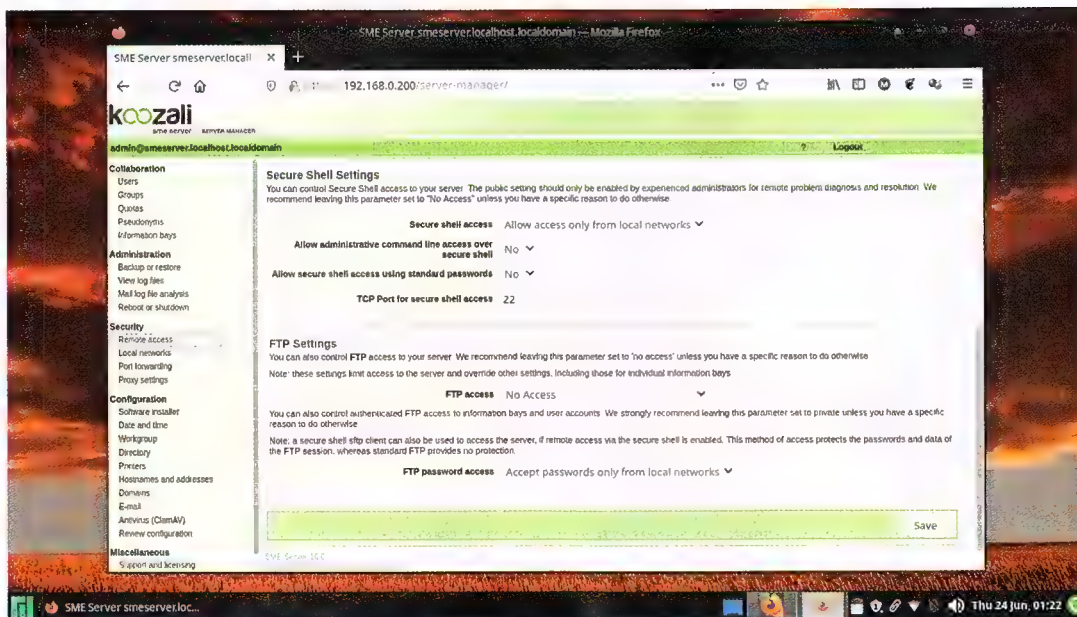
PIANO ACADEMY

Everyone knows Chopsticks.

Ever wanted to learn the piano but was put off by the expensive lessons? Piano Academy allows you to learn how to play via your phone, tablet or even real-life Piano via detecting the notes you play and capturing them into the application. Piano Academy starts slow – introducing you to notes, reading music, and playing in concert before gradually expanding the range to have you playing with both hands as well as banging out hits from both classical and contemporary pop. There are also some great little games included that help you work on coordination, rhythm and more. It's a solid app that is easy enough to be used by both children and adults – I was able to go from zero knowledge to playing a full song (on a tablet, to be fair) within a few hours. Highly recommended.

★★★★★





The one feature we particularly dislike is the software manager, which is functional, but has a terrible interface that severely impacts the user experience.

Minimum:
CPU: 1.8GHz
Memory: 4GB
HDD: 20GB
Build: 64-bit only

Linux | www.koozali.org

Koozali SME Server 10

Mayank Sharma has a particular fondness for point-and-click server distributions that roll out in a jiffy and don't eat into his leisure time.

Koozali SME Server exists in an interesting niche of distros that have successfully managed to abstract the process of deploying a feature-rich gateway network server behind a point-and-click interface, significantly streamlining the cumbersome process.

You can use SME as an effective gateway server that manages your network's connectivity to the internet. Not just for orchestrating the flow of network data to and from the computers inside your network, but also securing it in the process, minimising the risk of intrusions.

Its developers describe SME as a communications server that can be configured in one of three operational modes. The first is as a gateway server, which asks SME to take over firewall duties, and act as the external web and mail server. Second, SME can be used as a private gateway server, in which case it acts as a firewall but disables all incoming traffic, curbing the risk of intrusions. Finally, in the server-only mode, SME only looks after the computers inside the network, while gateway functions are performed by another server.

The latest release is based on CentOS 7, which will be supported by 30 June 2024, which gives enough time for SME to decide

whether it wants to move on to CentOS Stream or to one of the other drop-in CentOS replacements, such as Rocky Linux and Alma Linux.

One of the highlights of the release is that it finally supports USB installs, which is surprising since USBs have long become the de facto means of lugging images for personal consumption. In any case, the installation is a fairly simple affair, especially since like most server distros, SME is designed to take over the entire disk.

Booting into a freshly minted installation will take users through an ncurses-based configuration screen. Besides setting up passwords, the main purpose of the configuration is to decide one of the three operational modes for the server, and to set up any associated relevant settings. When used as a gateway server, you'll have to make sure the machine has two network interfaces, one to connect to the local network, and the other to the internet. Once you've configured the server, you can access its administration interface from any of the computers inside the network it is managing.

There isn't much about the browser-based interface to write home about. It's functional if unappealing, and works as it's supposed to. All configurable elements are listed in

the left sidebar under various categories such as Administration, Security and Configuration.

The distro also enables you to create backups and can restore a previous Koozali installation. In fact, on first boot, the distro prompts whether you wish to restore from a backup. Considering the fact that the latest SME release doesn't allow for in-place upgrades, you can rely on the server's ability to back itself up in a restorable format to shift to the latest release.

Once up and running, you can explore SME's interface to configure its features, such as the central file-sharing ability called i-bays. This works with the quote management functionality of the server to define the disk space for each user inside your network.

All things considered, the main criteria for rating a distro such as SME Server is the finesse of its graphical environment. Unfortunately for SME, irrespective of its list of features, its unpolished interface is a major disappointment. In fact, considering how little the interface has changed through the years, it appears the distro caters more to the needs of its existing user base rather than trying to lure new users.

One of the highlights of the release is that it finally supports USB installs, which is surprising since USBs have long become the de facto means of lugging images for personal consumption.

SME should think about polishing its user interface and offer optional paid support to challenge its more popular peers.

★★★★☆



Security Suite GROUP TEST

The threat landscape has changed in 2021, and so have the relative strengths of the options you have to stay protected. Nick Ross has the results and the surprise winner.

Since the turn of the Millennium, it's been a truism that if there's one type of software that you really needed to pay for, it was anti-malware. That all changed in recent years with top security suites offering free versions of their premium products which essentially provided the same top-tier, core protection gratis. In our previous group test we ended up recommending Bitdefender's free version, but what was arguably more notable was that Windows Defender, Microsoft's built-in anti-malware protection, performed just as capably – better in some instances – as all third-party products. Was this a one off? Do we even need to worry about Windows malware anymore? Of course we do... but the threat landscape has changed.

The 2021 threat landscape

Earlier this year, Australia's Information Commissioner stated that ransomware incidents had increased by 24 percent in the first half of 2021. These are incidents where an infected computer (or network) gets encrypted and you are prompted to pay a ransom (usually in cryptocurrency) to unencrypt it. If you don't do so before a deadline, the key is deleted and your data becomes irretrievable. She added that 30 per cent of those incidents were caused by human factors, which could have been down to someone making a basic mistake or being targeted by a phishing attack (where one's personal details are stolen). Kaspersky, meanwhile, states that a ransomware attack occurs every five seconds. While major institutions tend to be the target of high-end attacks, there are also still plenty of automated attacks targeting the general public.

Furthermore, many of the companies and apps we rely on for shopping, services and entertainment keep getting their customers' usernames and passwords published online due to breaches from lax internal security or lax security from a third-party developer. Just check the website www.haveibeenpwned.com and you'll likely see at least one of your passwords being regurgitated back to you.

Not surprisingly, these are the types of areas where many modern, premium, anti-malware suites now focus their attention – areas where Windows' inherent, anti-infection, security features can't help you.

What to look for in anti-malware software

A first rule of buying anti-malware is never to pay full price. There are almost always very-heavily discounted versions of software and you can easily save over 50 percent – even on manufacturers' own sites.

If you're going the free route, be sure that free means free. Many packages might identify issues but charge you to fix them. Meanwhile built-in VPNs (and cloud back-up storage) regularly comes with tiny amounts of free data that runs out quickly and demands you pay for more capacity.

Beware of being locked into an expensive premium product. Many packages offer to secure you (and your family's) life for a heavily discounted first year (or longer). However, once all your passwords, configurations and data are locked into the system, it's not always easy to move elsewhere and this can get expensive down the line when the discounts expire.

Finally, ask yourself, which features do you need to pay for and which ones can be found cheaper elsewhere? While it's tempting to have everything sitting in one place, there are many individual applications which can offer similar functionality for free or at better value. For instance, most web browsers (and applications like 1Password) offer excellent password management tools. Services like Carbonite offer great value back-up for all of your data without worrying about hitting expensive thresholds. CCleaner performs junk management and system tune-up tasks for free. Specialist VPN providers like Torguard offer well-featured, high-value services without limits.

How we test

We've once again based our group test on the perpetual, realistic testing performed by the specialist labs of AV-Test (www.av-test.org). These continually monitor antimalware applications and periodically publish reports on how the software has been performing across recent months. This feature's results are based on performance throughout May and June 2021. Default settings are used and the applications are allowed to update themselves (and even query their own cloud databases if available).

Each application is judged according to three criteria and scored out of six for each:

PROTECTION

How well does the application actually protect against real threats? AV-Test states, "Instead of being theoretically evaluated in simulated test conditions, products are required to fend off the latest attacks." This is in addition to the traditional weapons used by cyber criminals and includes zero-day malware, drive-by attacks, downloads from websites, infected email and much more.

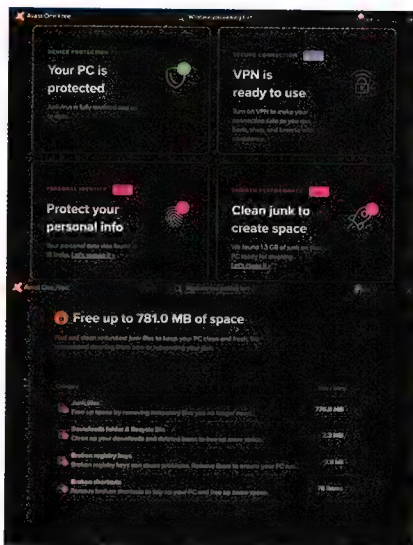
PERFORMANCE

Many of our older readers will still shudder at the thought of some early anti-malware programs grinding their computer to a halt when a scheduled (or impromptu) scan was run. In some scenarios, you'd have little choice but to disable the product entirely. Nowadays, while file sizes might have ballooned in order to fit in more features, great efforts have been made to reduce the impact on a computer's day-to-day operation. AV-Test's Performance score examines the extent to which an application affects the speed of the protected system using sophisticated tests under realistic conditions. Special attention is placed upon slowing down when launching popular websites, slower downloads of frequently-used programs, slower launch of standard software, slower installation of frequently-used programs and the slower copying of files (locally and across a network). It performs these tests multiple times on both a standard PC and a high-end PC.

USABILITY

Other traditional banes of security software are unwelcome warnings, pop-ups, notifications and false alarms. These are catered for in AV-Test's Usability score. Testing is spread across three stages. Stage 1 looks for false alarms and blocking when visiting several hundred popular websites. Stage 2 looks for false detections of legitimate software as malware during a system scan. Hundreds of thousands of products (dating back 15 years) are used for this test but only unambiguous results are used – for instance legit, remote admin and password recovery programs are skipped. Stage 3 is a false alarm test when installing standard software such as Adobe Reader, Google Chrome, Java and VLC Media Player. Anything warning the user or demanding user intervention is counted here.





Free | avast.com

Avast Free AntiVirus 21.4

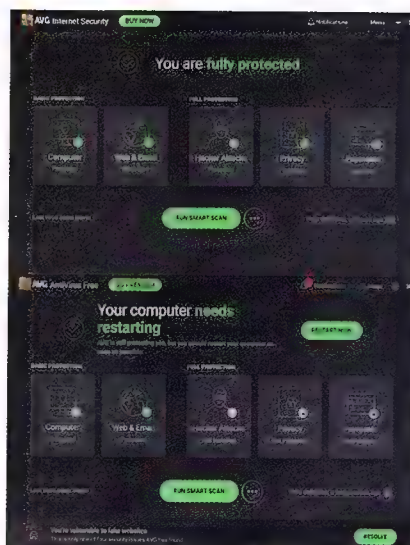
As we installed Avast Free Antivirus we were informed that it had evolved into Avast One Free. The new software is intuitively laid out and looks modern with its colourful graphics on a black background. While it did immediately offer to upgrade to the premium version, it only did this once and utilised plain language to describe the benefits.

The main screen has four areas: one informed we were safe against threats and that protection was up to date. Another informed us about password breaches we'd been compromised by and offered to monitor our accounts for leaks. A webcam privacy option is listed but it only works with premium. Another area allows you to activate a 'military grade' VPN. It's quick enough to use but the free version only offers 500MB of data per week, which isn't much. There's also a junk file scanning option. While it does well at identifying junk, you have to upgrade to remove anything, which is silly.

This all said, Avast scored top marks in all of AV-Test's criteria and is a simple-to-install, simple-to-live-with choice. If you want occasional access to VPN and to be alerted to new password breaches in your free AV, it's a good choice.

Colourful, unobtrusive high performance with some extra bells & whistles.

PROTECTION ★★★★★
PERFORMANCE ★★★★★
USEABILITY ★★★★★



From \$36 pa | avg.com

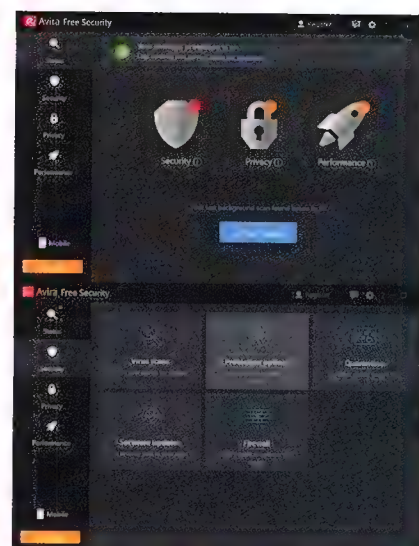
AVG Internet Security 21.4

AVG was purchased by Avast back in 2016 but the products are kept separate – though there are many similarities in terms of layout, features and looks. AVG feels somewhat fluffier when it comes to premium options. The main screen displays five categories in which you're protected but they're all very similar and there's significant overlap. They can also be somewhat confusing: the general Hacker Attacks category looks like it caters to beginners but the Enhanced Firewall configuration options certainly aren't. It also features a Remote Access Shield without explaining what it does or how it's different to other firewall sections listed in other categories.

While it doesn't take long to find everything, you have to scrutinise every option to see what it actually does. Included is Ransomware protection, (which secures important folders) webcam protection, a network monitoring tool, along with the usual features. It's relatively cheap at \$36 per year (especially at \$49 for 10 devices), but its protection is only a notch above free. If you want to use the VPN, it costs an additional, \$48 per year. Ultimately, AVG seems to be stuck in the middle ground between Avast free and Avast premium. If you want slightly better-than-gratis ransomware protection and network tools it might appeal.

A cheap premium offering... but it feels like it.

PROTECTION ★★★★★
PERFORMANCE ★★★★★
USEABILITY ★★★★★



From \$135 pa | avira.com

Avira Internet Security for Windows

Avira has historically performed well in APC group tests owing to the large number of features available in its free option. However, last outing we felt those options were too heavy on the upsell and didn't function properly without paying. Now, here's the full suite.

First up, we were disappointed to see it drop a full point in the Protection category – the raison d'être of anti-malware. The software also noticeably slowed down the loading of popular websites and installation of popular applications (which dropped it half a point for Performance). While it didn't bother the user too much, that's not helpful if you can't trust it to keep you safe.

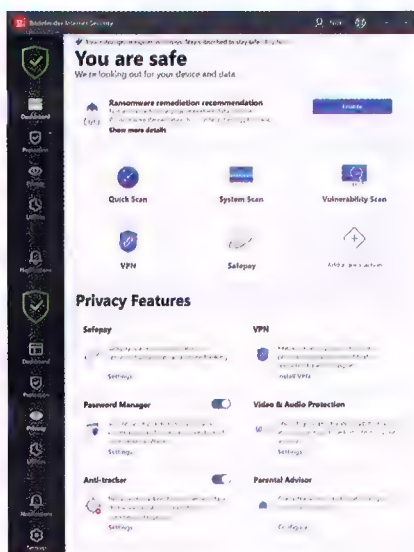
There are some tempting features, though. While the \$135 for five devices is mediocre, it does include a limit-free VPN (which is listed as an \$81 per year add-on to the free version). There's also performance enhancement software to speed up programs and monitor batteries on mobile devices.

The software is also intuitive and well laid out and we didn't have to rummage through menus or decipher 'helpful' labelling to find anything.

Ultimately, though, Avira falls down in for its Protection performance. While its score was still over 96 per cent, with competition so fierce, it's difficult to recommend.

Poor protection hobbles some otherwise interesting features.

PROTECTION ★★★★★
PERFORMANCE ★★★★★
USEABILITY ★★★★★



From \$99 pa | bitdefender.com

Bitdefender Internet Security 25.0

Bitdefender was a favourite, top performer in our last test: its free version offered best-in-market protection to the point where you needed nothing else. There are many different versions of its premium software and "Internet Security" is one of its top-end brands. Note that prices can vary wildly across different offers. The notional price here was \$99 for three devices, but official discounts saw it drop as low as \$40. However, if you want the VPN service, that's an additional \$50 per year.

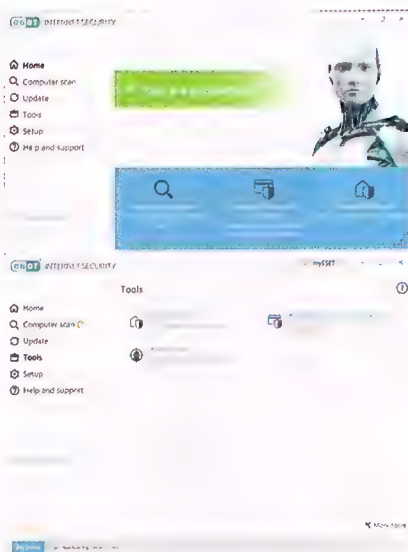
The software layout isn't quite as polished as seen elsewhere but it's simple and intuitive to use. The usual features are here plus ransomware folder protection. There are also anti-spam features (if you use an old-school email client) and parental control features which can be used to track your child's whereabouts.

It still offers top-tier protection without impacting on performance but did drop half a point with a few too many false detections. However, it appeared to have addressed these at the time of going to press.

Ultimately, it's hard to fault Bitdefender: the free version offers its top-tier protection engine and the premium version offers decent value and potentially useful features... so long as you actually use them and don't pay full price.

Still a great all-round, well-featured product with no major flaws.

PROTECTION ★★★★★
PERFORMANCE ★★★★★
USEABILITY ★★★★★



From \$59 pa | eset.com

Eset Internet Security 14.1

Eset's Internet Security might not look particularly modern but all the key tools are there. There's also a 'locate your PC' feature, front and centre, should it get pilfered (or your laptop lost). There are parental controls but these centre around content blocking rules (rather than limiting access times) and those are never infallible.

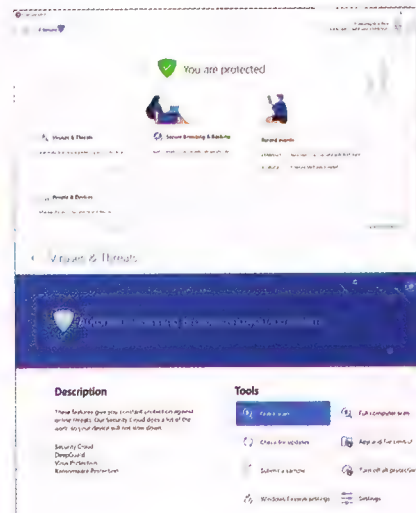
A 'Connected Home' scanning tool checks everything that's on your network for vulnerabilities. Meanwhile, banking and payment protection includes settings for cryptocurrency wallets. We always like to see a Gamer Mode feature, which stops scans and notifications during games and presentations.

Unfortunately, it dropped a full point in the important Protection test by failing to stop just over two percent of malware. While it's not the worst performer, in such a competitive market, peace of mind is what you're buying above everything else. Still, it managed top marks for Performance and Usability.

Licensing is flexible in that you can choose precisely how many devices you want protected and for how long. You're also offered licence options for small business. Ultimately, it's not a bad product but it doesn't really excel at anything and is only really worth considering if you want to make use of it for business licensing reasons.

A good performer but not great. Some interesting licensing options may prove attractive.

PROTECTION ★★★★★
PERFORMANCE ★★★★★
USEABILITY ★★★★★



From €59 pa | f-secure.com

F-Secure Safe 17 & 18

If software can inherit national characteristics then it might explain why the Finnish F-Secure is how it is: minimalist, efficient and a bit different are words that come to mind. The Viruses & Threats section does what it says and invites you to submit samples of potential malware you found. The Secure Browsing & Banking also does little more than tell you that you're protected. Meanwhile the People & Devices section opens your account information in a web browser and offers you to install the software on another device, install the separate VPN app (called, "Freedom") and install ID protection.

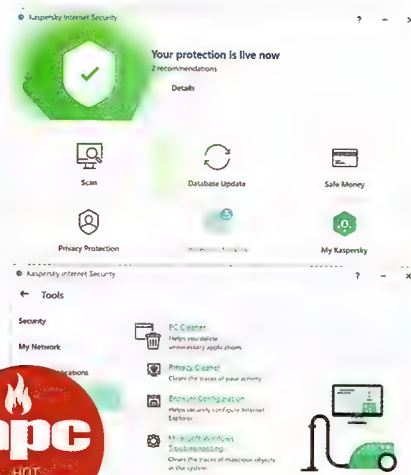
Pricing varies significantly and official, online versions are priced in Euros. They're very flexible though and you can purchase up to 25 licences for two years which is the most on test.

In terms of performance it scored full marks for Protection and Usability. However, it could slow down your PC when launching popular websites and installing some popular programs which dropped it half a mark.

Ultimately, there's lots to like with F-Secure Safe. It's no-nonsense, well put together, and the limitless Freedom VPN that comes with a full subscription can either be activated with a single button or configured to a high degree.

Simple, effective and has good VPN functionality.

PROTECTION ★★★★★
PERFORMANCE ★★★★★
USEABILITY ★★★★★



From \$21 pa | kaspersky.com

Kaspersky Internet Security 21.3

Kaspersky has always been a top, premium, security provider but it did have a habit of over explaining security issues to consumers. So, we were pleased to see that the latest Internet Security suite struck the perfect balance between simple labelling and explaining what a function actually did.

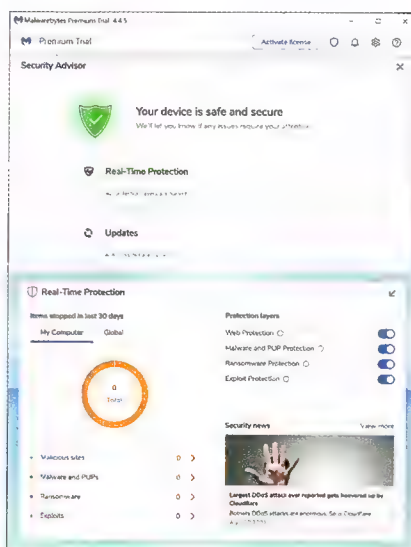
The features are packed in: along with webcam security and payment security there's additional cloud-based security for immediate notifications of new threats and a rescue disk option to recover a compromised computer. A VPN is included but 'only' offers 300MB per day which is fine for casual users but not for downloaders. There are also very good child management features which manage screen time, content access, and tracking. There are also good junk program clean-up tools and Windows troubleshooting applications. We were pleased to see it scored top marks for Protection, Usability and Performance impact in AV-Test's tests – it doesn't really have any failings.

You can usually find big discounts on licenses, which start at a very reasonable \$21 per year but stretch to 10 devices over two years.

If you feel limited by the 300MB VPN limit you can upgrade to unlimited traffic with additional features (like overseas Netflix!) for \$46 for five devices. So it's great value too.

Simple to use, great features and top-tier performance. And it's great value.

PROTECTION ★★★★★
PERFORMANCE ★★★★★
USEABILITY ★★★★★



Free / from \$60 pa | malwarebytes.com

Malwarebytes Premium 4.4.0

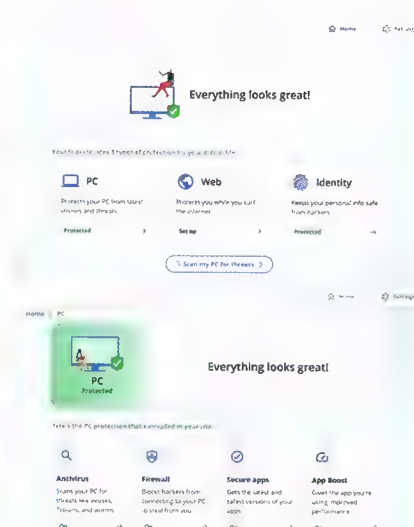
Malwarebytes Premium is an odd duck. Despite offering both a free version and a premium version, the premium version does little more than offer gratis-grade protection... and at a high price too. A single-unit, single-year license costs \$60 while for two years it's \$105, which makes it one of the most expensive and under-featured performers on show.

The main screen is simple enough to decipher and operate. Detection History tells you what it's detected, the Scanner shows running scans, while a Real-Time Protection option lets you individually choose between activating web protection, malware protection, ransomware protection, and exploit protection. There's a little more information available when clicking through to each section. The Settings offer some more features like Play Mode for uninterrupted gaming, Remote Desktop access, and Rootkit scanning. There's Exploit protection for apps but it's not clear what this does.

While it scored full marks for Performance and Usability it took a hit by allowing a few too many known threats through its net. Ultimately, it's hard to recommend Malwarebytes. It's under-featured, overpriced and doesn't offer much more than free equivalents. However, its greatest failing is to not protect against threats that have already been discovered and catalogued by the industry and so it's also difficult to trust.

Overpriced, under-featured and too many holes in its security net.

PROTECTION ★★★★★
PERFORMANCE ★★★★★
USEABILITY ★★★★★



From \$95 pa | mcafee.com

McAfee Total Protection 24.1

McAfee's software is generally well laid out and understandable although the huge "Everything Looks Great" messaging grates after a while, especially when it simultaneously flags issues. Oddly, many options are accessed through the secondary, settings dropdown rather than the main console.

Some features only activate with auto-renewal turned on, which is a bit cynical in trying to trap people into expensive subscriptions. These include Identity Protection features (which monitor multiple email addresses across the web) and the VPN. There's a file shredding tool and the usual payment, password, and folder security tools. An interesting Web Boost feature stops autoplaying ads from playing. Anti-spam features (potentially) usefully include webmail options.

Network monitoring tools allow you to identify devices on your network and block them as intruders. However, it doesn't do a good job of telling you what the devices actually are – it just displays an IP address and generic picture.

It performed well for protection but slowed down the installation of some popular applications. Pricing is rather harsh with individual licenses costing \$95 plus large hikes after the first year. The child protection features are only available in the 10-device Family pack, which jumps from \$90 to \$190 after year one. However, it does work across PCs, Macs, Android, and iPhones.

Decent protection but expensive and seems to be cashing in on name recognition to laypeople.

PROTECTION ★★★★★
PERFORMANCE ★★★★★
USEABILITY ★★★★★



Free | microsoft.com

Microsoft Defender 4.18

The last time we ran this group test, Microsoft's built-in software came joint top for protection. We were so shocked that we feared it might be an aberration: after almost 30 years, was Windows finally safe? Really? Like, really really? We ended up giving Bitdefender's free version the nod but promised that if Windows' own software could consistently perform this well then it would deserve to win. Now here we are.

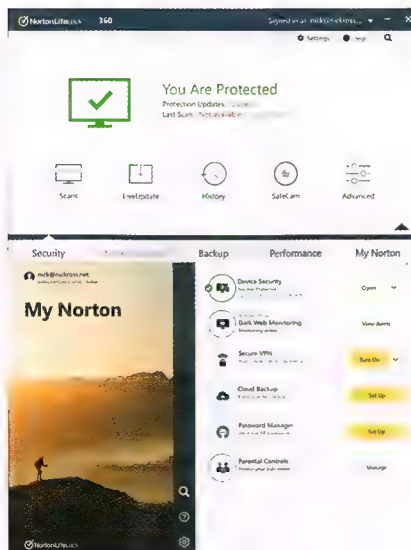
Defender scored a perfect 6 out of 6 for Protection and it was a similar result for Performance and Usability too. In doing so it's arguably undermined the entire consumer security market to the point where, theoretically, it's made it redundant. However, its hopefully pushed the premium manufacturers to raise their game by offering better features with their premium offerings.

There's no VPN, and parental controls are more a case of being a Windows feature, but you're well protected from general malware. Of course, that won't protect you from human error or website scams, and while OneDrive can protect encrypted folders, if you did allow yourself to get infested with Ransomware you'd need more than Defender to get you out of it.

But we can't make excuses anymore, thanks to Windows Defender, you no longer need basic malware protection.

■ The best free product. And it comes built-into Windows.

PROTECTION ★★★★★
PERFORMANCE ★★★★★
USEABILITY ★★★★★



From \$100 pa | norton.com

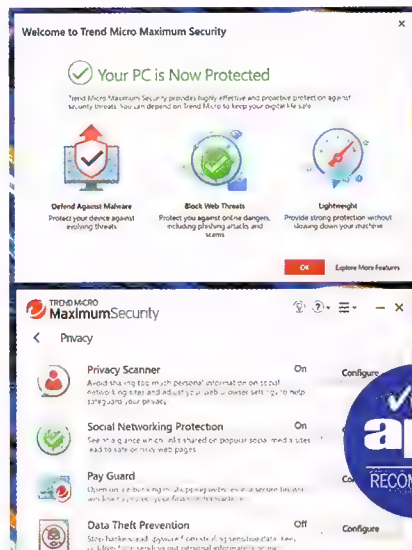
Norton 360 22.21

Norton 360 is available in many flavours and none of them are cheap. However, it packs in the features. It's got one of the smoothest set-ups around, including a nifty feature where it offers you a QR code to install software on your mobile device during setup. There's a Dark Web protection feature that checks your personal details aren't being traded. There's a good collection of performance-enhancing features and junk removal tools. There's a limitless VPN and very good child protection options. However, arguably the main reason for the inflated price is Cloud Backup. We're a little wary of this as it can fill up quickly. You only get 10GB with the \$100 individual license but even 50GB and 250GB won't backup your whole computer like a dedicated service such as Carbonite will.

It aced all of the Protection, Performance and Usability AV-Test tests with 100 per cent protection rates. It's been a long-term fire-and-forget stalwart choice whose behavioural protection has proved incredibly difficult to fox. All of the key features are there but the price has crept up – it's \$195 for the 10-device family protection after the discounted first year. Just note, once you give it your life to protect, it will be hard to stop paying.

■ Arguably the best all-round protection, but it can be hard to leave this expensive ecosystem once embedded.

PROTECTION ★★★★★
PERFORMANCE ★★★★★
USEABILITY ★★★★★



From \$89 pa | trendmicro.com

Trend Micro Internet Security 17.0

Trend Micro's security has been impressing us in router tests in recent times thanks to its network protection and parental controls. Its premium Internet Security suite is also very slick, offering an easy-to-understand, intuitive interface and asking, in straight English, whether you want added browser protection, parental controls, and mobile device protection added to the installation. The parental controls can automatically stop kids publishing personal information online in addition to controlling access and gaming time with internet time locks plus application access blocking at certain times. Other privacy settings include Social Networking protection, which flags unsafe links and monitors whether personal identification is appearing online. There's also a PCHealth Checkup tool and Mute Mode for gaming and presentations.

Licenses are a little high with up-front payments available for two, four or six devices for one or two years. They start at \$89 and go up to \$260, although it's normal for them to be significantly discounted.

In the AV-Test results, Trend Micro scored top marks for Protection and Performance but dropped half a point in Usability by flagging some innocuous software installations.

Ultimately, Trend Micro remains a solid, well-rounded choice that's good for families who want to protect their kids without the hefty Norton buy-in.

■ A good all-rounder with good parental controls.

PROTECTION ★★★★★
PERFORMANCE ★★★★★
USEABILITY ★★★★★

Conclusion

Is it even a contest anymore?

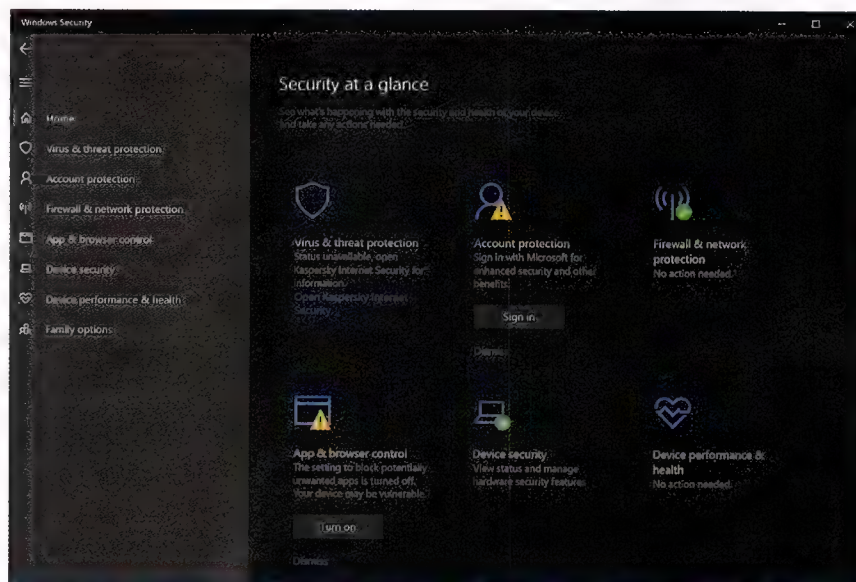
After decades of reviewing anti-malware products it feels incredibly weird to say that you don't need to buy them anymore because Windows is finally inherently protected. But fair's fair, Windows Defender has consistently done everything we've asked of it and deserves the title of Best in Show.

However, if such a verdict and a 30-year history of regarding the term 'Windows Security' as being an oxymoron, still gives you anxiety, know that Bitdefender's free version is still a great, lightweight alternative.

You still need protection

Of course, saying that you don't need protection for a computer nowadays is ridiculous – online threats, especially to companies, continue to proliferate. In many cases the weakest link in the chain is the user and it's increasingly simple to click on the wrong thing to get scammed or infected. Other times, a company you trust will get hacked and all its customer passwords (including yours) can get posted online. With this in mind, paying a premium for enhanced security still makes sense... but be wary.

On the one hand you've got the option of augmenting free antivirus with premium, dedicated applications like Carbonite for backup, Torguard for VPN, CCleaner for performance and Chrome for passwords. While enthusiasts might prefer this choose-your-own-bundle approach, there are still many gaps – especially if you want to include tools like webcam protection and parental



Windows Defender. Comes with Windows. Is free. Was once scorned, is now excellent. Quite possibly all you need, in fact.

controls. Consequently, putting all your eggs in one security basket can be appealing.

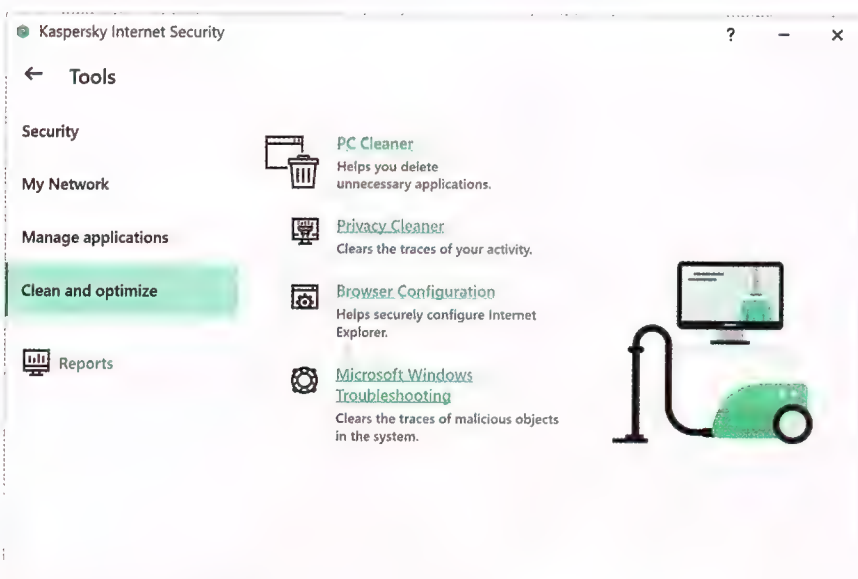
The issue with locking into one product

But remember, while there are usually heavily discounted versions of every product on the market, many products' prices increase substantially after the first year. If you've embedded yourself in Norton 360 and McAfee Total Protection, for instance – relying heavily on services like Cloud Backup and multi-device Parental Controls – extricating yourself and stopping

payments can be like trying to cancel a gym membership. It's a bit like buying into Apple's ecosystem in that it gets increasingly expensive and becomes ever-harder to switch. Nonetheless, if money is no object and you want excellent parental controls, we'd still point towards Norton 360 for no-nonsense simplicity, reliability and features... but it's not our premium recommendation.

The best overall premium product award turned into a race between Trend Micro Internet Security and Kaspersky Internet Security. Trend Micro doesn't lock you into an ecosystem and lets you know what you're paying up front. It's got great parental controls but it can be pricey if you don't need them.

That's why our preference for premium purveyor of anti-malware is Kaspersky. With licences starting at just \$20, pricing is reasonable and scales well depending on the features you need. All primary security features you could want are available including VPN, secure payments, anti-phishing, anti-ransomware, identity theft protection, webcam protection, keylogging protection, network protection, Android app locking and a Gaming Mode to stop it bothering you at crucial moments. It also aced all the AV-Test tests for Protection, Performance and Usability. Plus, it's very simple and intuitive to use. With no weak points, great features, a great interface and – the cherry on top – a great price, it's a worthy winner. ■



Kaspersky is our pick as the overall winner from the premium paid offerings.

PC GAMER

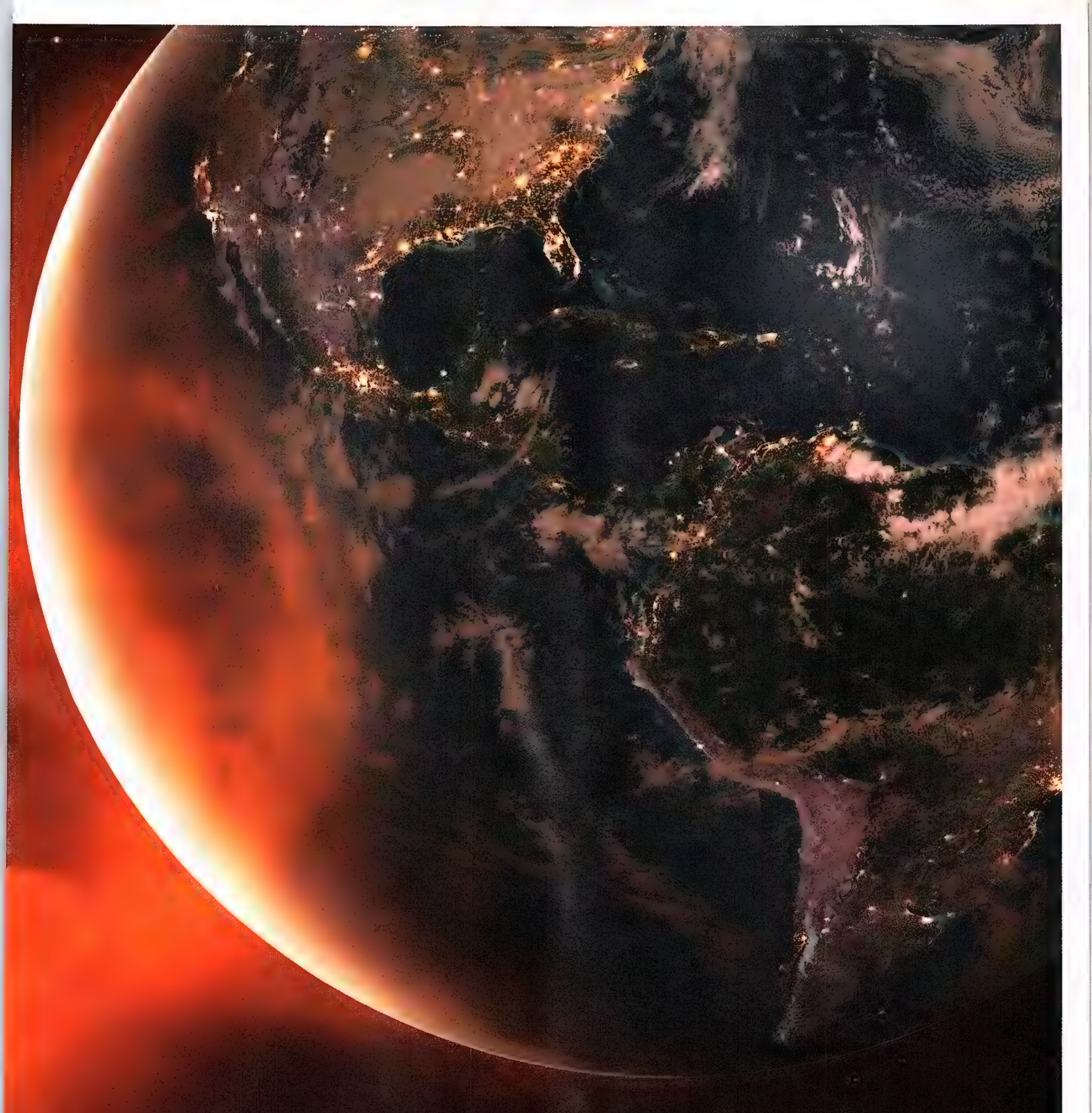
THE GLOBAL AUTHORITY ON PC GAMES

**Over 22 million gamers
visit us online every month.**

Join them.

www.pcgamer.com

EVENT ON THE HORIZON



Ian Evenden explains how the Sun could one day take out our electronics and communications technology in mere moments.

Earth, September 1st, 1859. Colours flash through the night sky above New England, gold miners in the Rocky Mountains are woken by the brightness of the Northern Lights, visible as far south as the Caribbean. Telegraph operators across the world receive electric shocks from their equipment, which continues to operate, despite being disconnected from the power supply.

The Sun, August 31st, 1859. A complex system of magnetic field lines suddenly twists, releasing a large quantity of plasma into space. This takes 17 hours to cross the 150 million kilometres to the Earth, which is at just the right place in its orbit to be hit by what today we'd call a coronal mass ejection.

The largest geomagnetic storm on record, the Carrington Event caused widespread electrical disruption and power blackouts in an electrical grid that was primitive compared to today's complex system.

Should it happen again, the consequences could be catastrophic: A 2013 research project from Lloyds of London and Atmospheric and Environmental Research in the United States estimated the cost to the US alone could be US\$2.6 trillion.

At the peak of its activity, the Sun belches out as many as three coronal mass ejections every day. One only just missed us in 2012, and if it struck today, the damage would be incalculable.

What's it all about?

In their day-to-day lives, our PCs and other electrical equipment are unlikely to come into contact with charged particles, but every now and then, the Sun reaches out to touch us. Protected in the Earth's magnetic bubble, we don't often notice the effects of the solar wind unless we live far enough north or south to see the aurora. Our Sun is, compared to other places in the Universe, a relatively placid, middle-aged star, but occasionally it can surprise us.

The Sun operates on an 11-year cycle. In 1859, it was approaching the middle of this cycle, the time of greatest activity. Astronomers, equipped with ever-improving telescopes, were starting to take more of an interest in the Sun around this time, and the first observation of a solar flare was made on September 1st that year by the astronomers Richard Carrington (for whom the solar storm is named) and (independently) Richard Hodgson, both based in southern England.

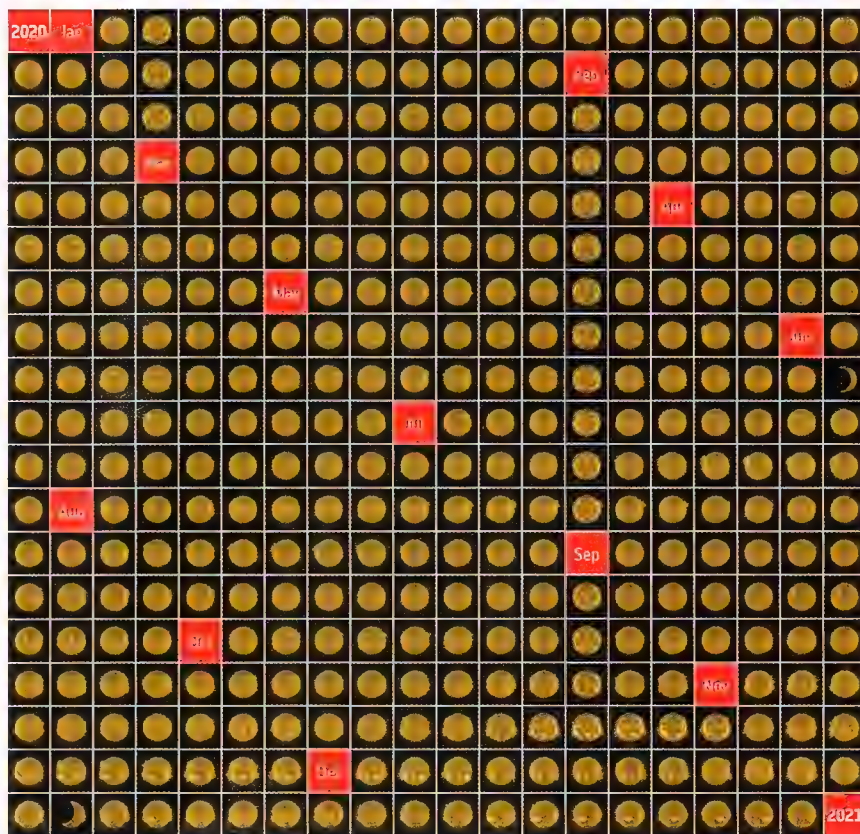
That flare, which Carrington observed by projecting the output of his telescope onto a screen through a broad-band filter (remember, never look at the Sun with the naked eye, or with any kind of magnifying equipment, or indeed with anything other than an approved solar filter) turned out to be enormous, a white light flare of extraordinary intensity.

Solar flares are associated with coronal mass ejections, and both are common when sunspots are on display, as these temporary, dark patches are signifiers of magnetic activity on the star's surface. As the 11-year cycle goes on, the sunspot count moves from none, sometimes for hundreds of days at a time, to anything up to several hundred at once.

Of sunspots and CMEs

Nobody was counting sunspots in 1859, though they were known to Chinese astronomers back in antiquity, and were mentioned by the Ancient Greeks. They were first drawn (that we know of) by an English monk in 1128. It took until 1610 to get a telescope on them, which is fair enough as the instrument was only patented in 1608, but it wasn't until the early 1800s that the astronomer William Herschel was able to associate sunspots with varying levels of solar activity. His hypothesis that an absence of sunspots led to higher wheat prices on the market, was widely ridiculed at the time.

While the precise nature of sunspots is still a matter of research and debate, it seems like he was right. Solar minima lead to cooler years, on average, which would have made wheat harvest smaller, pushing prices up. Fossil records suggest this cycle has been stable (between nine and 14 years, for an average of 11) for 700 million years. We're currently in an



Above: These 366 images of the Sun, taken by the ESA's Proba-2 satellite, represent every day during 2020. Activity comes and goes, including two partial eclipses.

Left: The STEREO probes are an identical pair of spacecraft designed to observe the Sun. They orbit ahead of and behind the Earth to get a stereoscopic view.

active, warm period, similar to that around the year 1000. There have been extended cool, low activity periods in the past too, most recently the 'little ice age' that ran from the 16th to 19th centuries.

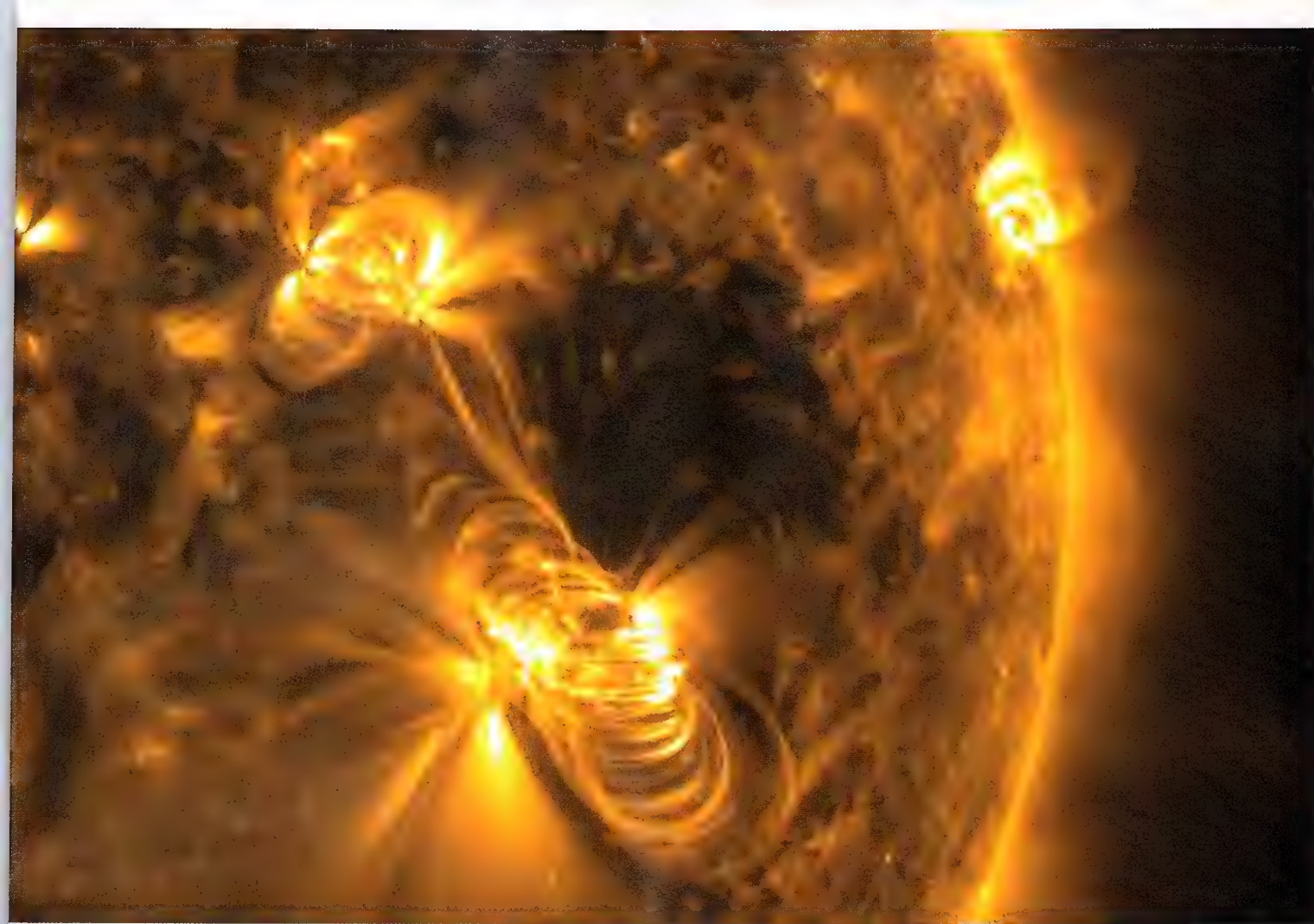
Sunspots appear to be the visible effect of magnetic flux tubes in the Sun's convective zone – an unstable layer just below the star's surface that's churning with convection currents as heat and other forms of energy are sent out by the fusion reactor running at its core. They are twisted and wound by differential rotation – different areas and depths of the Sun don't all rotate at the same speed.

So what happens when the irresistible force of the Sun's plasma ejection hits the immovable object of the Earth's magnetic field? "These large eruptions release large amounts of hot material called plasma," says Dr Ravindra Desai of Imperial College London, who previously

worked at the Los Alamos National Laboratory, New Mexico, and NASA Goddard Space Flight Centre, Maryland. Among other interests, Desai attempts to forecast the Sun's activity, a phenomenon known as space weather.

"When the plasma strikes Earth, it's deflected by the planet's magnetic field," he says. "The Earth protects us from the majority of the onslaught, but the plasma flows along those magnetic field lines and causes the Aurora Borealis, which is a wonderful thing to see, but it also causes [electrical] current systems in the ionosphere and the ground. They aren't dangerous to human beings, but can knock out power stations and satellites."

This happened in 1989, when a billion-ton cloud of plasma was ejected from a powerful explosion on the Sun at a million miles per hour. Two days later, it struck the Earth, sending aurora as far south as Cuba and causing the entire Canadian province of Quebec to lose power for 12 hours after its transformers blew. Electrical grids across the United States also saw drops in their power output, with over 200 incidents reported. Luckily, the US had enough power in reserve to keep the lights on. Satellites tumbled out of control, and the orbiting



Above: This solar flare was photographed by NASA's Solar Dynamics Observatory in 2017. Here, you can clearly see the coils of the Sun's magnetic field lines.

Space Shuttle Discovery developed a mysterious fault in one of its hydrogen tanks that disappeared at the same time the storm abated.

While the 2012 event missed the Earth by approximately nine days, it instead hit the STEREO A spacecraft, part of a pair of sun-observing probes that orbit both ahead of and behind the Earth to provide a stereoscopic image of the Sun. STEREO A (the probe ahead of the Earth) was largely undamaged by the plasma due to not being within a magnetic field at the time, but the failure of STEREO B led to the ending of the mission in 2018.

The 2012 event is thought to have been as powerful as in 1859, and it looks like Earth had a narrow escape. "If it had hit, we would still be picking up the pieces,"

said Professor Daniel Baker, director of the Laboratory for Atmospheric and Space Physics at the University of Colorado in a NASA statement in 2014.

"In my view, the July 2012 storm was at least as strong as the 1859 Carrington event. The only difference is, it missed. I am convinced that Earth and its inhabitants were incredibly fortunate that the 2012 eruption happened when it did. If it had occurred one week earlier, Earth would have been in the line of fire."

Chances of it happening again

Also writing in 2014 was the physicist Pete Riley, of Predictive Science Inc. He analyzed records of solar storms going back over 50 years, and by extrapolating the frequency of ordinary storms to the

extreme ones, he calculated the odds that a Carrington-class storm would hit Earth in the next ten years. His answer: 12 percent, or one in 8.3. We may have three years left on this prediction, but the threat doesn't go away after that.

As it happens, we're now entering a new solar cycle, the 25th since records began. This means that solar activity has been at a minimum for a while, "but in the last few months we've already started to see the Sun become more active," says Desai. Cycle 24, which ended in 2019, was a quiet cycle, yet included the enormous storm of 2012. Predictions have been made for Cycle 25, but anticipating the actions of a star is tricky, and different methods produce different results. "It's already releasing coronal

SPACE WEATHER FORECAST

"At the moment we have telescopes looking at the Sun," says Desai, "they see stuff happening on the Sun's surface, and as soon as a CME occurs we can start running our models to predict what time the CME will arrive, and when it does, what will its properties be – how big is its magnetic field, and how much plasma is contained inside of it. Typically, CMEs can take between

three and five days to reach us, but a severe one could reach us sooner."

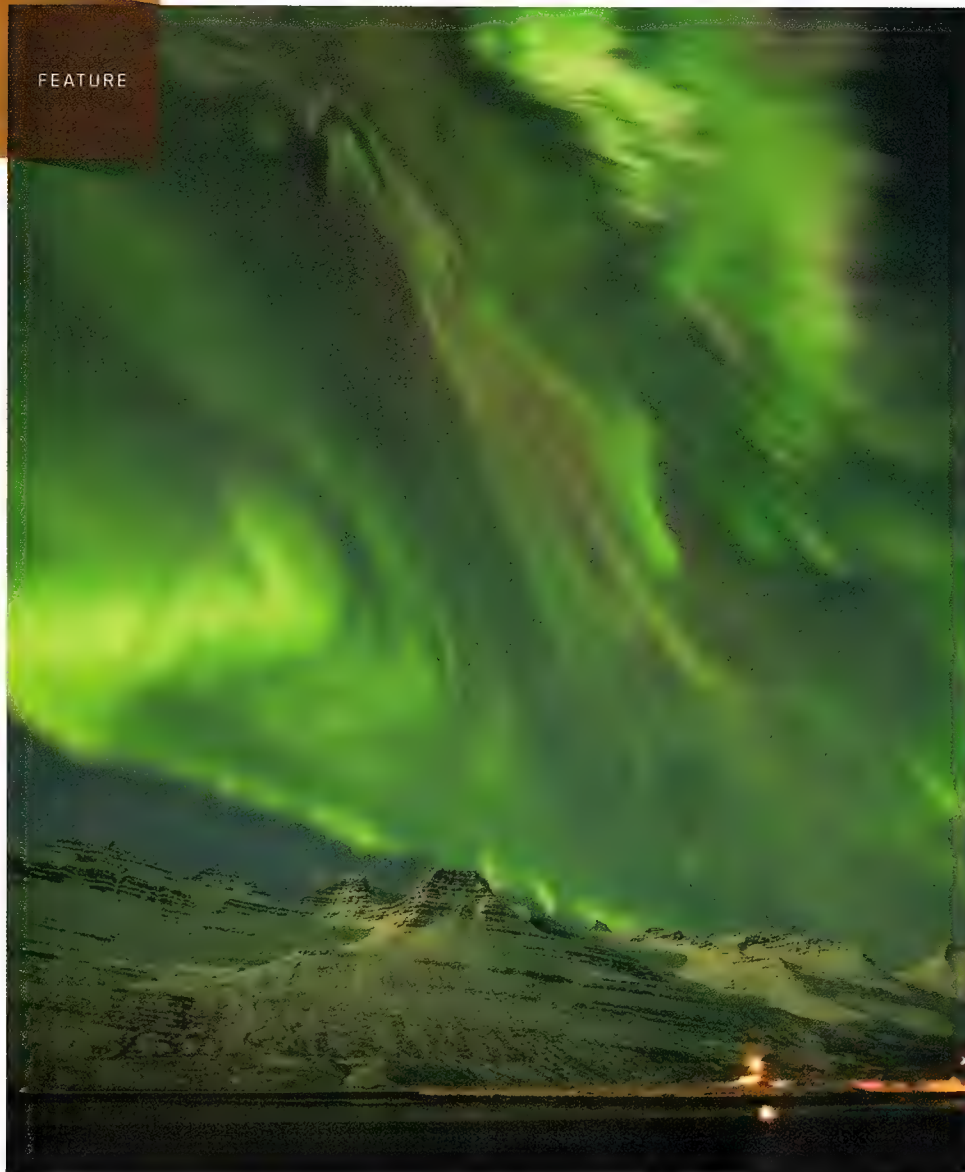
Indeed, NASA figures put the shortest time for a CME to cross the 150 million kilometres between us and the Sun as 15 hours, for a mind-boggling speed of almost ten million kilometres per hour.

Desai's team has discovered that, if CMEs come at us in pairs, then the second storm will be

more violent as a result. While investigating the 23 July 2012 event, they discovered a previous CME on 19 July. The four-day gap between the storms was long enough for the solar wind to recover from the stress, but by using computer modeling to place the second CME closer to the first, the Imperial team discovered that it became stronger, and faster.

If a CME is moving faster than

the background solar wind (a million mph), then ahead of the plasma cloud travels an interplanetary shockwave that can arrive at Earth with just an hour's warning. While this shockwave transfers its energy mainly through electromagnetic fields rather than particles, it can push particles ahead of it, increasing the chances of a radiation storm here on Earth.



Above: Aurora over Iceland in 2012 after a CME. As charged particles from the Sun collide with our atmosphere, different colors are generated – green for collisions with oxygen, and red for nitrogen.

mass ejections,” says Desai, “so the chances of a severe solar storm are getting higher.”

Those, as every *XCOM 2* player knows, are the kind of odds that do come up. “The effects could be pretty bad – it could cost the world’s economy trillions of dollars,” says Desai. “In terms of actual damage, it could knock out satellites, which would have an effect on our communication systems, anything from financial systems to those that open train doors. Also, electrical current systems in the atmosphere and on the ground can knock out large transformers, which is what happened to Quebec in 1989. Luckily, they were able to get things back online, but these transformers take many months to build. So if a huge solar storm happens, and knocks out these transformers, a worst-case scenario could be that it takes many months, if not years, to get our grid capacity back up to where it was before.”

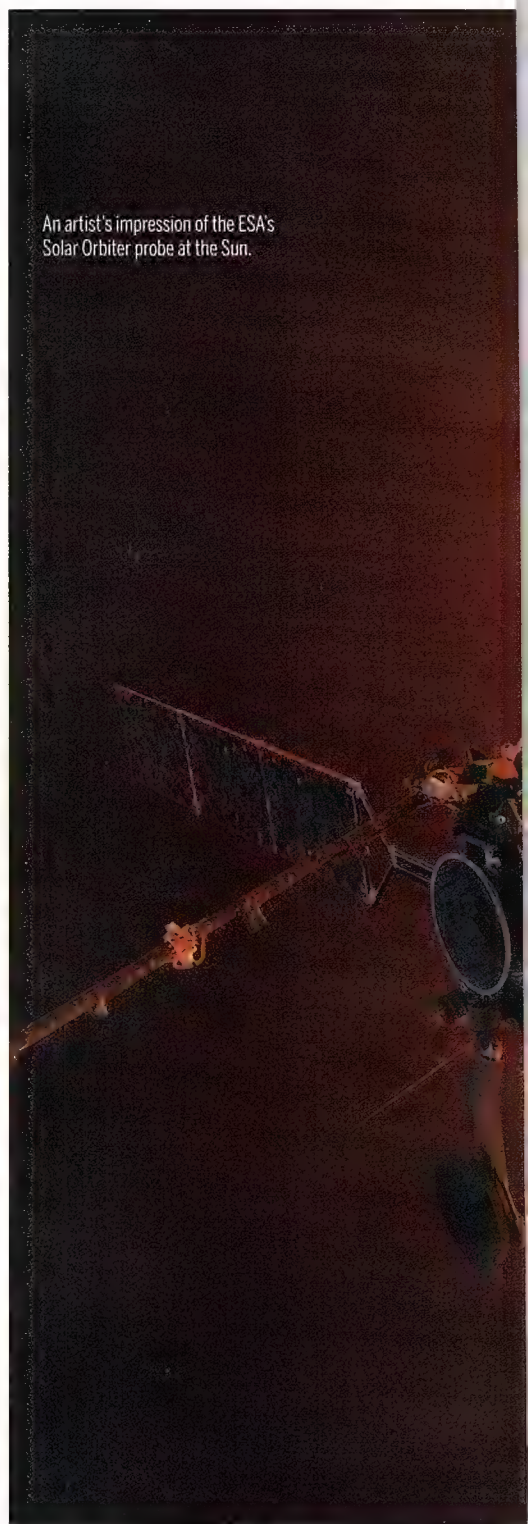
Cosmic ray processor lockup

Energetic particles don’t have to come from our Sun, though. Cosmic rays, high-energy protons, and atomic nuclei zipping through space at almost the

speed of light can come from as far away as other galaxies, possibly from supernovae. The most powerful are carrying an energy level 40 million times that produced in the Large Hadron Collider, described as like being hit by a baseball traveling at 90kph. Most, however, don’t have this kind of energy, but when they hit our atmosphere they still cause a shower of secondary particles, some of which will reach the surface and affect our electronics.

A study by IBM in the 1990s suggested there was one cosmic-ray-related error per 256MB of RAM per month. In a machine with 64GB of RAM, that’s 250 cosmic ray errors a month or 8.3 a day. In 2008, Intel patented an on-chip cosmic ray detector that repeated commands it decided had been affected by charged particle interference. Wherever they come from, energetic particles cause electrical currents to move through our atmosphere, and also in the tiny electronics of our CPUs and other devices, providing power where it’s not wanted, in the same way the telegraph operators were unable to switch off their equipment in 1859. Whether it’s burning out your logic gates or frying the nearest

An artist’s impression of the ESA’s Solar Orbiter probe at the Sun.



substation, CMEs are bad news for electronics.

What, though, happens if you’re not protected by the Earth’s magnetic field? Astronauts aboard the International Space Station have to take shelter in the more heavily protected (often Soviet-built) parts of the station during a solar storm, and they’re only 400 kilometres above the Earth’s surface. If you’re making a probe that will travel further afield, then you need to do something to protect it from radiation. Something like the European Space Agency’s Sun-observing Solar Orbiter, for example.

“There is no plan to avoid coronal mass ejections,” says Piers Jiggins of the ESA’s Space Environments and Effects section. “A major high-level goal of the Solar



Orbiter mission is to observe eruptions on the Sun and then to correlate those observations with in-situ measurements. From an instrument standpoint, we require that they can observe the [entire] range of plasma and radiation thrown at them, which at the closest passage of Solar Orbiter can indeed be 10-20 times more intense than what we might see close to the Earth. It's more interesting for us to be able to predict them, in case it could be used in operational planning, so we get back the most interesting data.

Plasma can cause charging on the spacecraft's surfaces, so it's important that we use conductive surface materials, paints, and coatings to dissipate this charge and avoid potentially damaging discharges. The higher-energy radiation

can penetrate the spacecraft shielding and deposit energy in dielectrics and other spacecraft materials, affecting their electrical and material properties. We need to take this into account when designing the electronics for spacecraft because how they can perform at the end of their lives can be different from at the beginning. This often means operating components in safe zones at lower voltages – a process known as de-rating. The short-term impact of solar radiation storms includes upsets in electronics and memory, which can manifest as non-destructive events requiring correction, or destructive events requiring mitigation.”

If you're designing a computer to run in space, then you need to build it for the

environment. Meet the Rockwell DF-224, 50kgs of silicon that measures 18x18x12 inches and runs at 1.25MHz. This was the original computer fitted to the Hubble Space Telescope and was considered for use on the Shuttle too. It's a highly redundant design, both to mitigate the effects of radiation and because maintenance in space is hard. So there are three CPUs, one active and two backups. Six memory units, of which four could be powered up at once, three I/O controllers, and six independent power converters. Aboard Hubble, the first servicing mission upgraded the DF-224 with a 16MHz 80386 as a co-processor, then the third servicing mission swapped the lot for a 25MHz 80486. Hubble was recently restarted following a switch to

its backup Power Control Unit, showing the resilience of this 90s-era technology.

Spaceproof CPUs

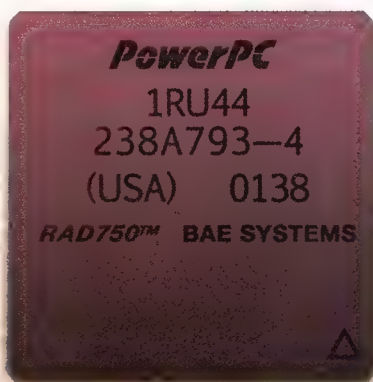
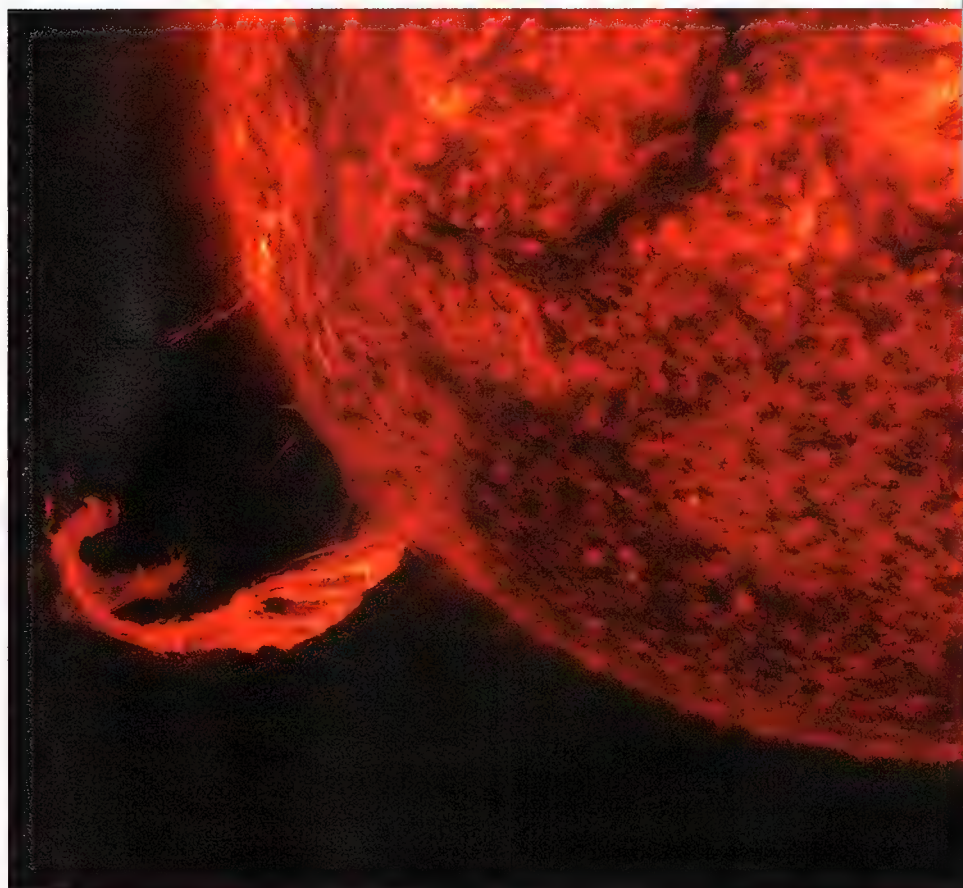
Making a processor that can be used in space – as opposed to the relatively balmy environment of the International Space Station, where Linux-based ThinkPads are the norm – means more than just redundant design. Take the BAE Systems RAD750, the CPU in various space telescopes, the STEREO probes, and the Perseverance rover on Mars. It's based on an IBM Power design known by Apple as the G3, is manufactured on either a 250nm or 150nm process, and with its attendant motherboard is good for temperatures of -67°F and a radiation exposure of 1,000 grays (five would kill a human). The RAD750, a chip that graphic designers gave up in the 2000s, is state of the art for space CPUs, and costs US\$275,000.

You'd get better performance for your space-buck if you used off-the-shelf components, but unfortunately, this has been tried. A Russian attempt to explore the Martian moon of Phobos, known as Fobos-Grunt, prioritised budget over spaceworthiness, and 62 percent of its chips were not qualified for going into space. Some, the SRAM, had been tested in a particle accelerator and were found to be extremely vulnerable, latching-up (a short circuit where a voltage spike in one transistor can spread to others nearby) at the minimum levels of particles it was exposed to. Still, the Russian space agency stuck it on top of a rocket and fired it at Mars in November 2011.

Explanations differ, but one story, sourced from a Russian military newspaper, is that a particle passed through the SRAM preventing the probe from firing its engines to get out of the low Earth orbit provided by the Zenit-2M rocket. The dual processors in the onboard computer initiated a reboot, then went into safe mode to await instructions. These never came, because the antennas the probe used to listen to ground control were extended in the cruise stage after it left Earth orbit. No antennas meant no engines, and no engines meant no antennas. The probe, worth 2.4 billion rubles (approx AUD\$111 million), fell into the Pacific ocean in January 2012.

Going nuclear

There's another way that our electronics could end up on the wrong end of the electromagnetic force, and that's thanks to a nuclear explosion. Like a coronal mass ejection, the EMP generated by a nuke is a short-term phenomenon rather than the constant bombardment of radiation in space. A nuclear device detonated at the right altitude could



bathe the entire continental US in EMP, having a "catastrophic" effect on communications and the grid infrastructure, according to a 2008 report from the EMP Commission.

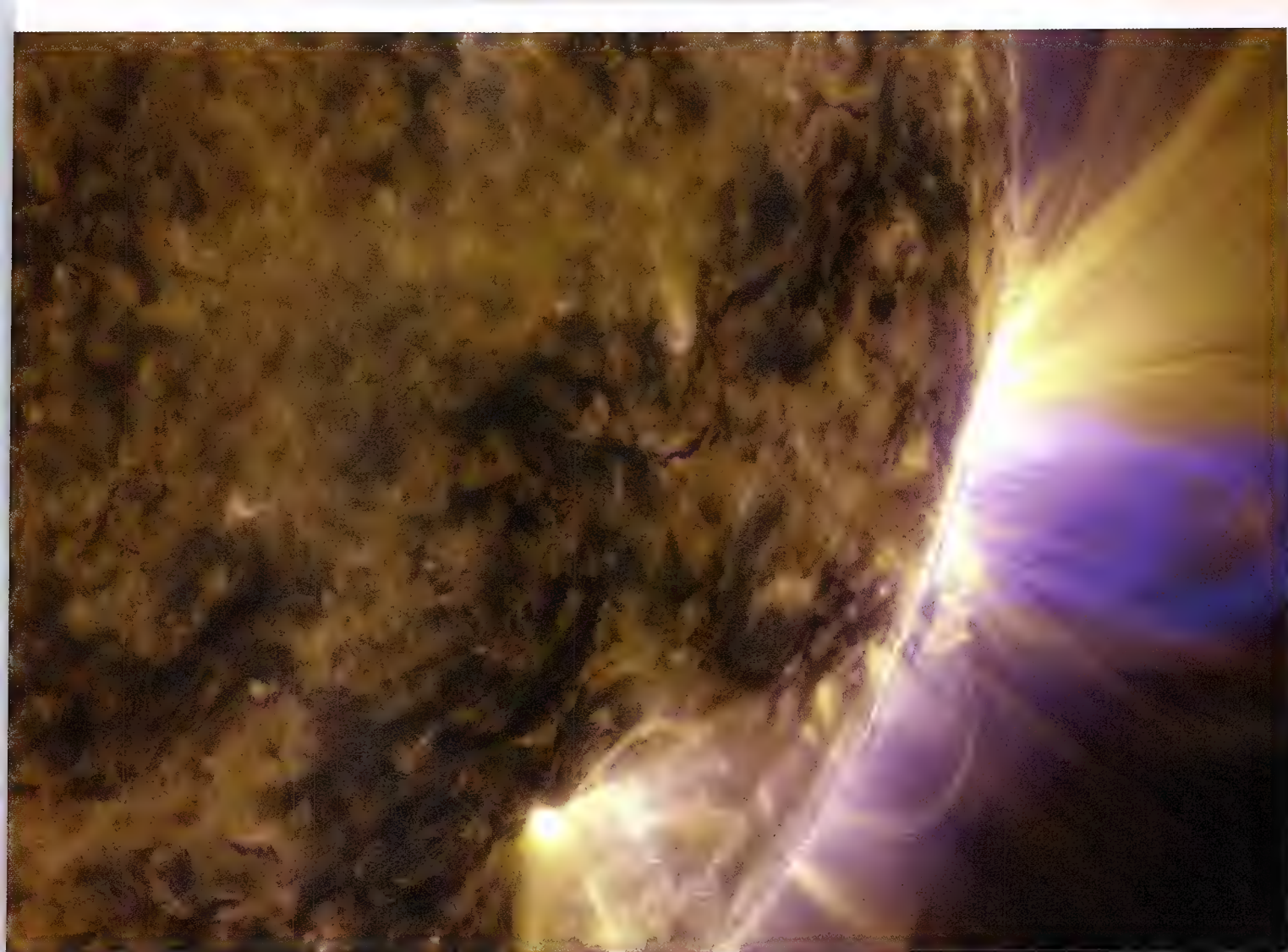
The group was formed in 2001 to "assess the nature and magnitude of potential high-altitude EMP threats to the US from all potentially hostile states," and its report (https://bit.ly/MPC_boom) makes for terrifying reading. It discusses how everything from water and food supplies to transport and fuel distribution would be affected by a burst of charged particles from the upper atmosphere. A high airburst would inflict maximum damage – explode close to the ground and it loses much of its energy into the Earth.

Above: This coronal mass ejection was recorded by the Solar Dynamics Observatory in February 2015. A substantial part shot off into space.

Left: BAE Systems' RAD750 CPU is based on the same IBM architecture as Apple's G3.

As with CMEs, ionised particles passing through the chip cause currents that can lead to transistors randomly opening, or latch-ups. These phenomena cause bit-flips, where a 1 or 0 becomes a 0 or 1, changing the content of memory or the data being processed. Using ECC memory is one way of dealing with this, and the errors can often be cleared with a power cycle, but enough voltage can cause a transistor to burn out, and long-term exposure causes gradual degradation of a processor or memory chip as electron-pair holes build up in the gate insulation layers. Eventually, the charge built up by charged particle bombardment can keep transistors to stay open or closed. The smaller your production node, the more likely you are to suffer the effects of charged particle damage, so as our tech advances, we make it more likely to fail in the event Earth is hit by a CME or EMP.

Chips designed to mitigate these problems are often built on an insulating substrate rather than the normal semiconductor wafer, such as silicon-on-sapphire, which uses aluminum dioxide's insulation



Above: Magnetic loops known as 'flux ropes' rise up from the Sun in this image from the Solar Dynamics Observatory.

properties to prevent stray currents doing an end-run through the substrate and leaking into more of the chip. Space-grade sapphire chips can withstand up to 3000 gray, and eliminate latch-ups. It's also possible to build in redundancy at the bit level, with each logical bit replaced with three.

Another method is to have three microprocessor boards instead of one, all doing the same calculations and comparing answers. Any minority answers are recalculated, and a board that consistently reports a wrong answer is shut down or restarted. Restarts can be carried out on a timer to clear bit-flips, while a simple radiation shield – a slab of

lead or other material in sufficient amounts – prevents particles from reaching the silicon. When launching into space, however, every fraction of an ounce counts, so heat shields are made with clever design, keeping as much of the body of the spacecraft as possible between the CPU and the source of radiation.

Keeping a spare laptop under a lead cover may be the only way to guarantee your tech survives Earth being hit by a CME of the scale seen in 1859. How useful that will be in a world devoid of an electrical grid or functioning communications is another matter, but at least you'll be able to play Minesweeper

until the battery runs out. Older tech, such as ham radios, seem more likely to survive due to their relatively large transistors being less likely to burn out in a voltage spike, but there's a catch: HF (shortwave) signals bounced off the ionosphere for over-the-horizon communications can be disrupted by solar activity such as radio bursts or the X-rays given off by solar flares.

The Sun always seems to be one step ahead of us. At least, with satellites monitoring the Sun and space weather simulations being run on supercomputers, we should get some warning this time. ■

CALL A QUANTUM MECHANIC

Quantum computers are notoriously unable to deal with any kind of interference from outside their enclosed systems, often cooled to just above absolute zero for their quantum bits, or qubits, to operate properly. And by properly we mean in a way that makes no sense according to the rules by which we usually understand the universe.

Instead of being limited to the binary digits of 1 or 0, quantum computers are able to reach a

'superposition' of both at the same time, thanks to the peculiar properties of the subatomic particles they're built upon.

The differences in voltage that maintain these states are tiny too, which means anything that can artificially raise or lower a voltage can upset the system.

This is why they're often kept so cold, so that heat from the outside can't seep in and mess up the calculations.

As it stands, quantum

computers generally run for a matter of microseconds before something causes them to collapse, although we're getting better at keeping them stable as we add qubits and ramp up the calculating power.

A recent paper published by MIT professors suggests cosmic rays and radiation from the Sun could be a greater threat than anything else, limiting future quantum computers to four milliseconds or so of operating before they

decohere. An energised particle hitting a quantum computer could cause a shockwave effect within a sufficiently complex processor, causing the qubits to fall over like dominos.

The solution? Future quantum computers may have to be built under layers of lead shielding, or underground, to protect them from the natural particle showers.

PLUG & PLAY PI PROJECTS

Jonni Bidwell explains how to make the most of the versatile Raspberry Pi device.

We love the Raspberry Pi here at APC. And so does Les Pounder. So with his help, we've put together the finest Pi projects for you to enjoy. From retro gaming to home security, or even artificially intelligent object classification, there's something here to inspire everyone.

The Raspberry Pi is the perfect device for learning Linux. Its official operating system is based on Debian Linux and there's even a build of Ubuntu for it. The Pi 4 is powerful enough that it can happily replace your desktop, and small enough to hide behind your monitor. Then there's the Pi Zero, which is perfect for budding Internet of Things enthusiasts. And now there's the Pi 400, where the keyboard is the computer.

Of course, there's no need to stop at these projects. We want you to boldly go exploring new computing frontiers, and we hope this offering inspires just that. With a bit of practice and experience, you'll be soldering up hardware or controlling robots – the only limit is your own imagination.



Get your kit ready

Prepare your USB cables, SD cards, and a cup of tea. It's time to start looking at some Raspberry Pi projects...

With more than 34 million units sold, the Raspberry Pi is not only one of the world's most popular computers, it's also one of the most important. Designed to help kids learn about technology, this inexpensive, single-board system is the leading choice for makers, developers, and hobbyists who want to do everything from building industrial robots to setting up retro arcade machines. Whether you're aged eight or 80, if you love technology, the Raspberry Pi is for you. And with models costing from \$40 to \$150, it will suit any budget.

Whatever you do with your Raspberry Pi, you will need an SD card with an operating system on it. The official Raspberry Pi OS (formerly Raspbian) is a popular choice and a great start for many projects. It's available in Desktop and Lite flavors at www.raspberrypi.org/software/operating-systems. There's an official Raspberry Pi Imager utility that you can use to write this (or a selection of other OSes) to an SD card, or you can use the NOOBS tool. We favour Balena Etcher, which has the advantage of being able to handle compressed images.

Troubleshooting

In this feature, we'll use a few different OS images, so we've made a handy guide to writing them below. If you run into difficulties, it's worth remembering



The latest incarnation, the Pi 400, embodies a Pi 4 computer (pictured) within a keyboard.

that a faulty SD card might be to blame, so it's worth trying a different one if things go wrong.

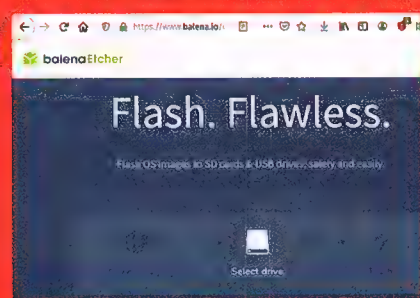
Cheap power supplies are another cause of errors. For older model Pis, these are less of a problem, but the Pi 3 and above really do need a good 5.2V or they'll be subject to CPU throttling and instability. The Pi 4 has switched its power input from micro-USB to USB-C and, unfortunately, this new port isn't USB-C compliant. So if you use a fancy smart charger, it probably won't power the device, and might possibly damage it.

You won't run into these issues if you

use the official charger, so do that. If you're opposed to that, we're told that cheaper USB-C cables (ones that lack the smart charge chip) work fine. Cheaper chargers should work too, but may not be so reliable.

We've handpicked some fun, useful, and interesting projects to showcase the tremendous scope of things that can be achieved with the humble Pi. From retro gaming to machine learning and Bitcoin, the possibilities are truly endless...

HOW TO Writing SD cards with Etcher



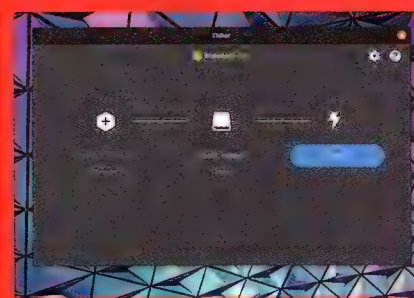
01 Download Etcher

You'll find Linux, macOS and Windows builds at <https://etcher.io>. Linux ships as a zipped AppImage, so once unzipped, run `chmod 777` on the file (or Select Properties > Permissions and check the box). Double-click the AppImage to run it (or do so from the CLI).



02 Prepare the target

Insert your SD card, select the Flash A device option and navigate to your downloaded image. Click Select target and a menu will show available devices (hard drives are hidden to prevent overwriting). Select your SD card reader, and check there's nothing important on it.



03 Write the image

Hit Flash, enter your password and wait for the progress bar. You'll be offered the chance to write the same image again (eg if you're preparing a fleet of Pi clones). Otherwise, your SD card is ready. Move it from your PC to your Pi, power on and let the adventures begin!

Image recognition

Get into machine learning and train your Pi to recognise and classify other Pis, without having to write a line of code.

You'll need

- Raspberry Pi 3, 4 or 400 • 8GB (or larger) microSD card • Raspberry Pi Camera or a USB webcam
- Power supply for your Raspberry Pi • Smartphone for taking photos • Selection of Pis or other objects for classification

We're going to train our Raspberry Pi to identify other Raspberry Pis (or other objects) with machine learning (ML). Why is this important? An example of an industrial application for this type of ML is identifying defects in circuit boards. As circuit boards exit the assembly line, a machine can be trained to identify a defective circuit board for troubleshooting by a human.

Other neat applications of machine learning and artificial intelligence could include facial recognition and face mask identification. For these types of projects, you can store the training images locally on the Raspberry Pi, however, the training process may take longer if performed on the Pi. So, for this tutorial, we'll use a web platform called Edge Impulse, one advantage of which is the ease of uploading training images. This can be done from a smartphone, without

having to involve an app.

We'll use BalenaCloudOS instead of the standard Raspberry Pi OS, since the folks at Balena have pre-built an API call to Edge Impulse. Some facial recognition and face mask identification tutorials also require tedious command line package installs and Python code. This project eliminates all terminal commands and uses an intuitive GUI instead.

Training on the Edge

Go to <https://edgeimpulse.com> and create a free account (or login), from a browser window on your desktop or laptop. Select Data Acquisition from the menu bar on the left. You can either choose to upload photos from your desktop or scan a QR code with your smartphone and take photos. In this tutorial, we'll opt for taking photos with

our smartphone. Select Show QR code and a QR code should pop up on your screen. Scan it and select Open in browser and you'll be taken to a data collection site. You won't need to download an app to collect images.

Accept permissions on your smartphone and tap Collecting images? in your phone's browser screen. Tap Label and enter a tag for the object that you take photos of. Take 30-50 photos at various angles. Some photos will be used for training and other photos will be used for testing the model. Edge Impulse automatically splits photos between training and testing. Repeat the process of Entering a label for the next object and taking 30-50 photos per object until you have at least three objects. We recommend three to five identified objects for your initial model. You'll have a chance to re-train the model with more photos and/or objects later on.

From the Data Acquisition tab in the Edge Impulse browser window, you should now see the total number of photos taken (or uploaded) and the number of labels (type of objects) you have classified. You can click any of the collected data samples to view the uploaded photo.

Some facial recognition and face mask identification tutorials also require tedious command line package installs and Python code. This project eliminates all terminal commands and uses an intuitive GUI instead.

Collect data

You can collect data from development boards, from your own devices, or by uploading an existing dataset.

Connect a fully supported development board Get started with real hardware from Nordic, Arduino, OpenMV, ST, Eta Compute, Himax and SiLabs - fully supported by Edge Impulse.	Browse dev boards
Use your mobile phone Use your mobile phone to capture movement, audio or images, and even run your trained model locally. No app required.	Show QR code
Data from any device with the data forwarder Capture data from any device or development board over a serial connection, in 10 lines of code.	Show docs
Upload data Already have data? You can upload your existing datasets directly in WAV, JPG, PNG, CBOR or JSON format.	Go to the uploader
Integrate with your cloud The enterprise version of Edge Impulse integrates directly with the data stored in your cloud platform.	Contact us

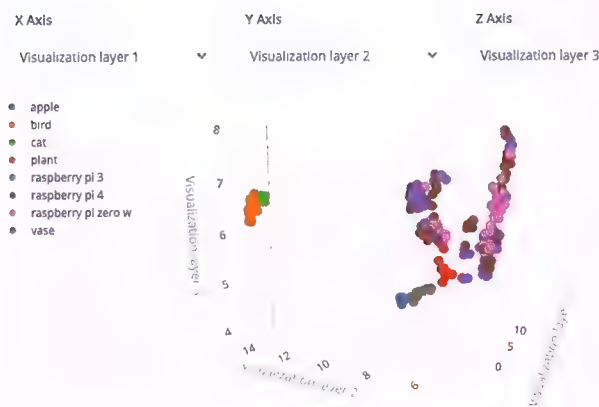
As well as collecting images from your mobile, Edge Impulse can connect to lots of data sources.

Impulse design

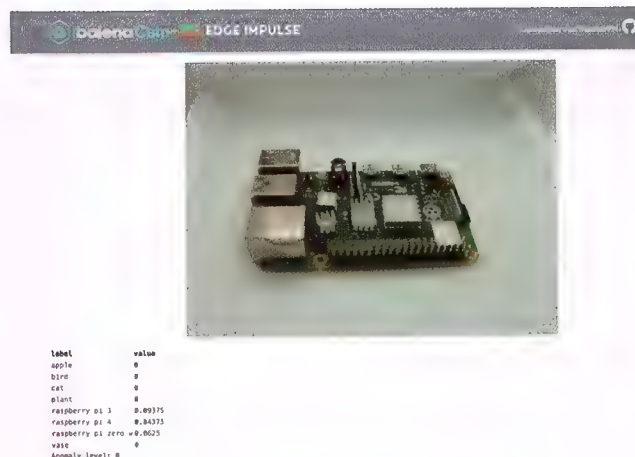
Click Create impulse from Impulse design in the left column menu. Click Add a processing block and select Image to add an image to the second column from the left. Click Add a learning block and select Transfer Learning. Click the Save Impulse button on the far right. Click Image under Impulse design in the left menu column. Select Generate features to the right of Parameters near the top of the page. Click the Generate features button in the lower part of the Training set box. This could take five to 10 minutes (or longer) depending on how many images you have uploaded.

Select Transfer learning within Impulse design, set your Training settings (keep the defaults, check Data augmentation box), and click Start training. This step will take five minutes or more, depending on the amount of data. After running the training algorithm, you can view the predicted accuracy of the model. For example, in this model, the algorithm can only identify a Raspberry Pi 3 correctly 64.3 percent of the time and will misidentify a Pi 3 as a Pi Zero 28.6 percent of the time.

Select Model testing in the left column menu. Click the top check box to select all



Gather datapoints (images), and Edge Impulse can explore and graph the features of the data.



We can forgive the machine for thinking this Pi 3 was likely to be a Pi 4. At least it knew it wasn't a plant.

and press Classify selected to test your data. The output of this action will be a percentage accuracy of your model. If the level of accuracy is low, we suggest going back to the Data Acquisition step and adding more images or removing a set of images. Select Deployment in the left menu column and select WebAssembly for your library. Scroll down (the Quantized option should be selected by default) and click the Build button. This step may also take three minutes or more, depending on the amount of data.

Setting up BalenaCloud

Instead of the standard Raspberry Pi OS, we'll flash BalenaCloudOS to our microSD card. The BalenaCloudOS is pre-built with an API interface to Edge Impulse and eliminates the need to attach a monitor, mouse, and keyboard to our Raspberry Pi.

Create a free BalenaCloud account at <https://dashboard.balena-cloud.com/signup> and then go to <https://dashboard.balena-cloud.com/deploy> to open the Create and Deploy page and create a balena-cam-tinyml application. Click Deploy to Application. After creating your application, you'll land on

the Devices page. Don't create a device yet!

In Balena Cloud, select Service Variables and add two variables. First, add to the service `edgeimpulse-inference` a variable named `EI_API_KEY` and in the Value field paste the API key from the Keys section of the Edge Impulse Dashboard. Add a second variable to the service named `EI_PROJECT_ID` and paste the Project ID value from the Dashboard. Select Devices from the left column menu in BalenaCloud, and click add device. Select your Device type (Pi 4, Pi 400, or Pi 3).

Select the radio button for Development. If using Wi-Fi, select the radio button for Wi-Fi+Ethernet and enter your credentials. Download your customised BalenaOS image and write it to an SD card.

Connect the hardware

Remove the microSD card from your computer and insert it into your Raspberry Pi. Attach your webcam or Pi Camera and then power up your Pi. Allow 15 to 30 minutes for your Pi to boot up and BalenaOS to update. You can check the status of your Pi Balena Cloud OS in the BalenaCloud dashboard.

Identify your internal IP address from your BalenaCloud dashboard device. Enter this IP address in a new browser Tab or Window. Place an object in front of the camera. You should start seeing a probability rating for your object in your browser window (with your internal IP address). Try various objects that you entered into the model and perhaps even objects you didn't use to train the model.

Instead of the standard Raspberry Pi OS, we'll flash BalenaCloudOS to our microSD card. The BalenaCloudOS is pre-built with an API interface to Edge Impulse and eliminates the need to attach a monitor, mouse, and keyboard to our Raspberry Pi.

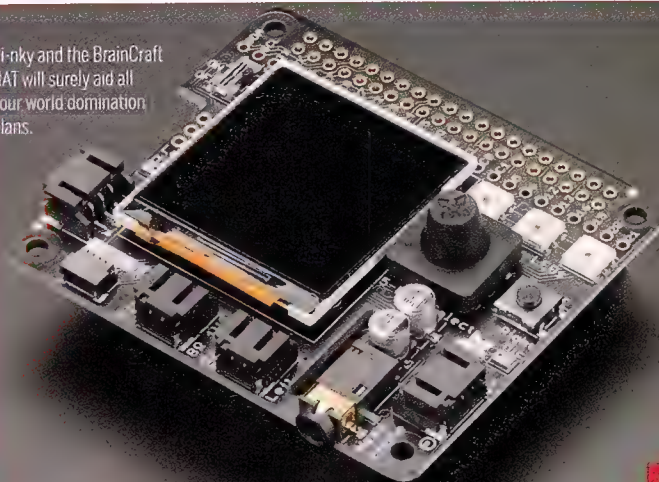
REFINING THE MODEL

If you find that the identification isn't accurate, first check your model's accuracy for that item in the Edge Impulse Model Testing Lab. You can add more photos by following the Data Acquisition steps and then selecting Refine model in Edge Impulse. You can also add more terms by labeling and uploading in Data Acquisition and retraining the model. After each refining, check for accuracy and then redeploy by running WebAssembly within

Deploy again

If you want to go further with machine learning, check out Pimoroni's new BrainCraft HAT for the Pi 4. It features a 240x240 TFT FPS display for inference output, slots for a camera connector, cable, a five-way joystick, two microphones, audio outputs, and much more. Most importantly, it has a controllable fan to keep the thing cool during all the server-rendering TensorFlow computations.

Pi-inky and the BrainCraft HAT will surely aid all your world domination plans.



Multi-room Pi audio

Get your Raspberry Pi playing music around the house.

You'll need

- Raspberry Pi 4 or Pi 400 (one unit per room) • 8GB (or larger) microSD card, U3 cards recommended. One per room • 3.5 mm audio cables • Amplified speakers or a receiver with 3.5mm/phono audio input • Power supplies for your Raspberry Pis • Optional: Smartphone or tablet

Multi-room audio systems can cost a pretty penny, but who needs to buy an expensive set of wireless speakers when you can use some Raspberry Pis and any 3.5mm wired speakers to achieve the same effect? We'll use our Pi 4s and speakers/receivers (with 3.5mm audio inputs) to play music from a streaming service perfectly in sync via Bluetooth from our phone, tablet, or computer. We'll show you how to do this with a single speaker and Raspberry Pi and then replicate it in other rooms. This is an excellent project for repurposing old

receivers. If you have a non-Bluetooth receiver with a 3.5mm jack input, you can connect your speakers to your receiver and your receiver to your Raspberry Pi.

Instead of Raspberry Pi OS, we'll use BalenaSoundOS to make the Bluetooth connection visible (to our other devices) and eliminate the need for a monitor, keyboard, and mouse for our Pi.

Create a free BalenaCloud account at <https://dashboard.balena-cloud.com/signup> and log in. Open the Deploy a Balena-sound application page at

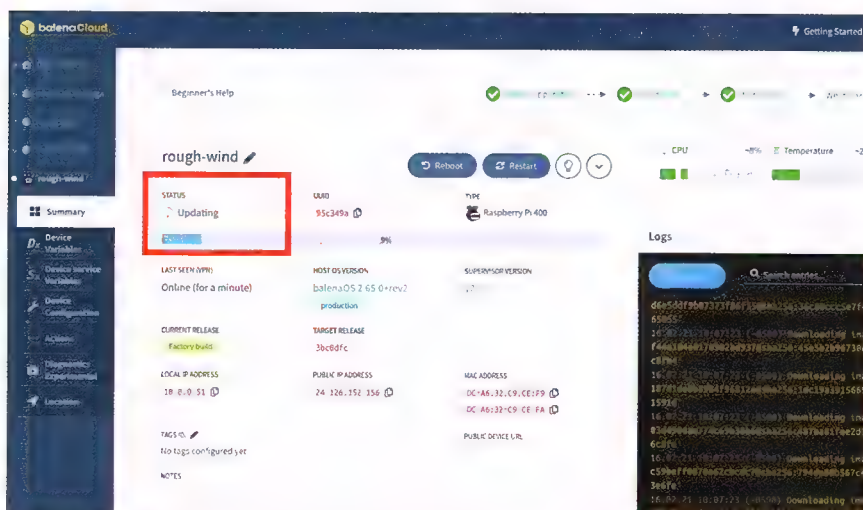
<https://sound.balenalabs.io/docs/getting-started>. You must already be

logged into your Balena account for that link to work. Click Deploy to Application and select Devices from the left column menu in your Balena-Sound Dashboard. Click Add device and choose Raspberry Pi 4, Raspberry Pi 400 or Raspberry Pi 3. Select the radio button for Development. If using Wi-Fi, select the radio button for Wi-Fi+Ethernet and enter your Wi-Fi credentials. Click Download balenaOS and a zip file will start downloading. Write this to an SD card, using Balena Etcher, or otherwise.

Connect and update

Remove the microSD card from your computer and insert it into your Raspberry Pi. Connect the speaker to your Pi via the 3.5mm audio cable. Power up your Pi. Allow 15 minutes for your Pi to boot up and BalenaOS to update – only the initial boot requires this long update. You can check the status of your Pi Balena Sound OS in your BalenaCloud dashboard. If you're using a Raspberry Pi 400, connect a USB speaker instead of the 3.5mm audio jack. Wait for your Raspberry Pi BalenaOS update to finish and confirm that all systems are running.

From your smartphone, tablet or computer, navigate to your Bluetooth settings and look for BalenaOS XXXX and pair it to your device. Connect the device as the sound output for your smartphone, tablet, or computer. Go to your streaming service and play a song. The music should stream via Bluetooth to your Raspberry Pi and play from the attached speaker.



Your musical Pi can be monitored through the Balena Cloud dashboard.

MULTI-DEVICE/MULTI-ROOM SYNC

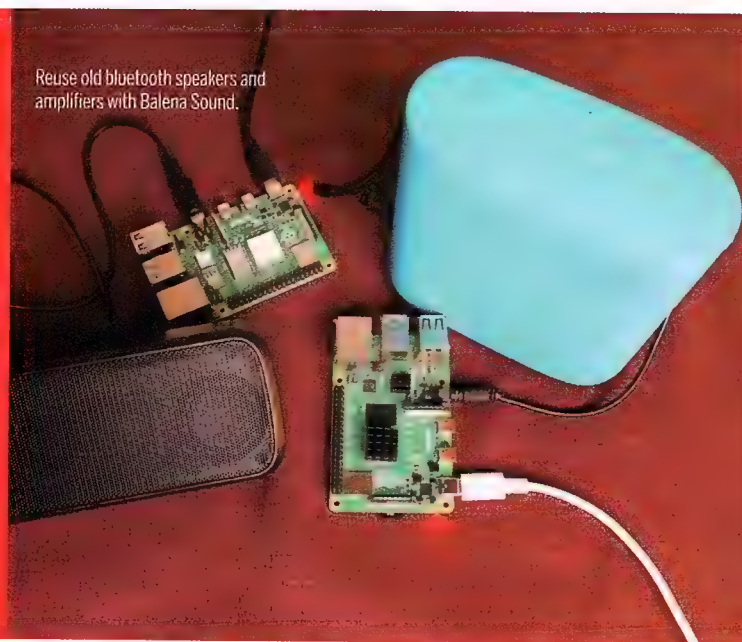
For multi-device sync, repeat the setup stages we described above for each extra device. You can flash the same image from earlier, if you're using the same model of Raspberry Pi. With the same Bluetooth device connected as before, music can now stream to all Raspberry Pis and then connected speakers. You will only need to connect one Pi via Bluetooth to your phone, tablet, or computer to stream to all Raspberry Pi Balena Sound speakers.

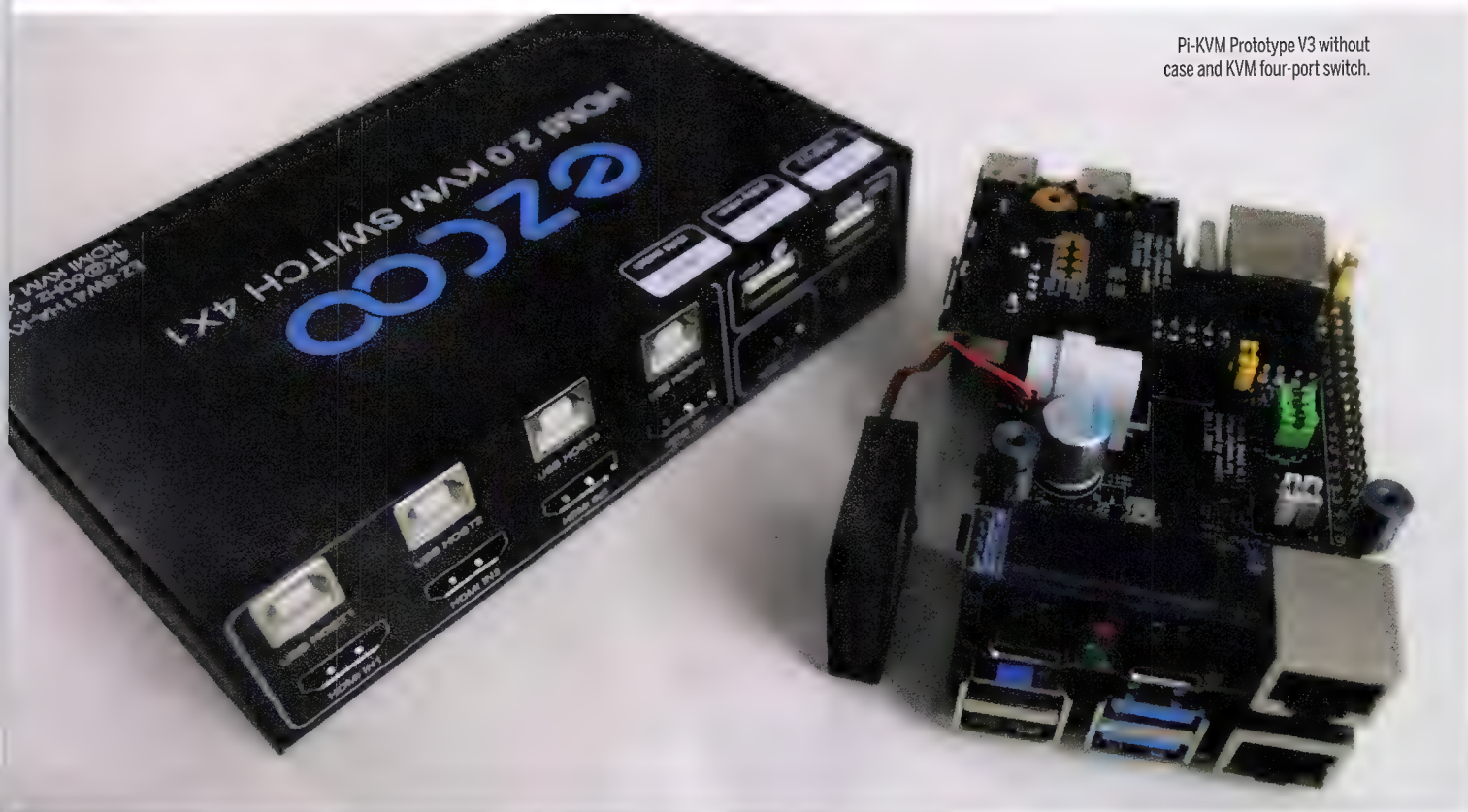
That's it. You can now create multiroom and multi-device sound experiences in your home

with your Raspberry Pi devices while Djug from your smartphone, tablet, or computer like a pro.

Audiophiles probably won't care much for Bluetooth audio, nor the headphone output on the Raspberry Pi. Fortunately, there are a variety of DAC (digital analog converter) HAT boards that enable faithful audio reproduction for not much money. IQAudio has been part of the Pi community since 2015 and we've long been a fan of its range of DAC and amplifier boards. Now IQAudio is part of Raspberry Pi and these boards are being added to the range of Pi products.

Reuse old bluetooth speakers and amplifiers with Balena Sound.





Pi-KVM Prototype V3 without case and KVM four-port switch.

Pi-based KVM over IP

If your PC won't boot to an OS, use your Pi as a remote control.

You'll need

- Raspberry Pi 4 or Zero • 16GB or larger microSD card • HDMI-to-CSI bridge or HDMI-to-USB capture dongle
- USB female-to-dual male Type-A splitter • USB C to Type-A cable • 5V, 3 Amp power supply with USB Type-A output. You'll be plugging a type-A cable into it, so the official Raspberry Pi power supply won't do

Those who have needed to access a PC remotely will probably have tried VPN or other applications such as TeamViewer. However, this kind of software only works within the remote computer's OS, which means it can't access the BIOS, reboot, install an operating system or power on the computer. There are several solutions that make it possible for you to remote control a PC independently of its operating system, but using a KVM over IP is one of the most convenient and affordable approaches.

While a store-bought KVM over IP device can be expensive, it's easy to use a Raspberry Pi to create your own. Developer Maxim Devaev designed his own system called Pi-KVM (<https://pikvm.org/>), which he's planning to sell as a US\$130 kit. However, if you have the right parts, you can use the software with your Pi, to put it together for far less.

Here, we'll show you how to build your own Raspberry Pi-powered KVM over IP that can output Full HD video, control GPIO ports and USB relays, configure server power using ATX functions and

more. You can control the whole setup via a web browser from another device on your local network.

Download the image

First, download the SD card image from pikvm.org. There are different versions, depending on which Raspberry Pi you use and whether you use the HDMI-to-CSI bridge or an HDMI-to-USB capture dongle. The file is bz2-compressed, but Etcher can handle this automatically, so follow the guide from earlier and write it to an SD card.

Next, install the HDMI-to-CSI bridge or USB-to-HDMI dongle and prep the OTG USB-C cable. Connect the CSI ribbon cable from the HDMI-to-CSI bridge to the Raspberry Pi's CSI camera port. Make sure that the blue marking faces the black clamp. If you're using an HDMI-to-USB dongle, connect it to a USB port on your Pi. If you're using a Pi Zero then you'll need a micro-USB-to-USB Type-A hub.

Disable the 5V pin on one of the USB Type-A male connectors from your splitter. The easiest way to do this is to place a

small piece of Kapton tape over the right-most pin. If you don't disable it, then it will back feed the power from your wall power to the PC, possibly causing damage to its USB port.

Connect the USB C-to-A cable to the Type-A female connector on the splitter. This will provide power to the Pi. Connect the USB-C cable to the Raspberry Pi 4's USB-C port and connect the unmodified Type-A male to your power supply. Attach the USB Type-A connector and HDMI to the PC that you wish to remote control.

The Pi-KVM software

We're ready to start using the Pi-KVM. On first boot, it will take longer than expected due to the initial process for enlarging the microSD card. Be patient, it will boot eventually. Navigate to the Pi's IP address (look it up in your router's control panel or use Nmap) in a browser on your client computer (the one you're using to control the other PC). You'll be redirected to the login page, which you should log into using admin for both username and password.

Click the KVM icon. You should be presented with a screen providing access to the remote PC and a number of other menus. Further options and instructions are available from the Pi-KVM GitHub.

Environment sensors

How does our garden grow? With Raspberry Pis all in a row.

You'll need

- Raspberry Pi (any model)
- GrovePi or GrovePi Zero
- Adafruit 1.3-inch Bonnet (or other display)
- GrovePi Sensors (temperature, moisture, light)

With more extreme weather conditions predicted in the future, the green-fingered amongst us may need to keep a closer eye on their plants. Temperature is one variable that can be displayed and graphed by a Pi with an LCD display, so for this project, we'll take that idea a step further by measuring a range of environmental variables. Thermistors and most other components that measure such factors, are analog in nature, so they aren't immediately suitable for the Pi, which only has digital (GPIO) inputs. However, thanks to HATs like the GrovePi, it's easy to get your Pi talking to analog sensors. We used a high accuracy temperature and humidity sensor, a soil moisture meter, a light sensor, but more are available and getting them working with GrovePi is super easy.

We won't cover setting up the Pi (any model will do), but you'll probably want to get it set up for SSH and Wi-Fi access, especially if you're planning on installing this in your greenhouse. You may have to coerce your Pi into using Python 3 by default (if it doesn't already). This is a matter of

```
$ sudo update-alternatives --install /usr/bin/python python /usr/bin/python2.7 1
```

```
$ sudo update-alternatives --install /usr/bin/python python /usr/bin/python3.7 2
```

Now we can set up the GrovePi board, and Dexter Industries provide a script

that will do this in one line:

```
$ curl -kL dexterindustries.com/update_grovepi | bash
```

Vision on

You'll need to reboot once everything's done, at which point we can start setting up our display. There are a huge range of TFT, OLED or LCD screens available for the Pi so this depends on your hardware. We used Adafruit's 1.3-inch Pi Bonnet display and to set that up we had to install Pip and then install its Blinka library, which enables interfacing with their CircuitPython APIs:

```
$ sudo pip3 install --upgrade adafruit-python-shell wget $ https://raw.githubusercontent.com/adafruit/Raspberry-Pi-Installer-Scripts/master/raspi-blinka.py python3 raspi-blinka.py
```

Then reboot and you should be ready to go.

Reading from our combined temperature/humidity sensor requires copying and pasting from <https://github.com/ControlEverythingCommunity/TH02>, since the bit-banging is complex. But our moisture and light sensors can be read with one liners:

```
import grovepi
moisture = grovepi.analogRead(1)
light = grovepi.analogRead(2)
```

Having got data from the sensors, we need to get it on the display. The Adafruit Python libraries enable images to be sent directly to the display, so we can use the Pillow libraries to help us. There is some boilerplate to initialise the display (which we'll omit here, but you'll find it at <https://learn.adafruit.com/adafruit-1-3-color-tft-bonnet-for-raspberry-pi/python-stats-example>):

```
from digitalio import DigitalInOut, Direction
from PIL import Image, ImageDraw,
ImageFont
import adafruit_rgb_display.st7789 as
st7789
```

Then you can use regular PIL image and text commands to draw the info on screen

```
height = disp.height
width = disp.width
image = Image.new("RGB", (width, height))
rotation = 90
image.draw = ImageDraw.Draw(image)
```

Loop the loops

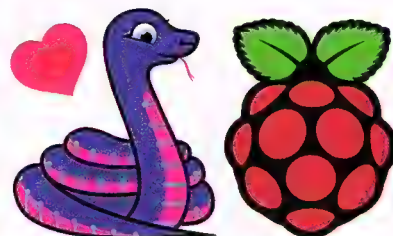
For this project to be useful, we need the display to continuously update. We make a loop, which clears the screen, updates readings, pauses and repeats

```
fnt = ImageFont.truetype("/usr/share/fonts/truetype/dejavu/DejaVuSans.ttf", 30)
while True:
    moisture = grovepi.analogRead(1)
    light = grovepi.analogRead(2)
    draw.rectangle((0, 0, width, height),
        outline=0, fill=0)
    draw.text((20,120), "Light {}".format(l),
        font=fnt, fill="#FFFF00")
    draw.text((20,210), "Moisture {}".
        format(m), font=fnt, fill="#00FFFF")
    disp.image(image)
    time.sleep(0.5)
```

You can go further with this project, such as logging and graphing temperatures with GnuPlot. Or connect a watering system via a relay and never have to worry about your peonies drying out again!



Stack the display on the GrovePi daughterboard, plug in sensors and you'll never have dry peonies again.



Adafruit's Blinka library enables Python to talk CircuitPython, a variety of MicroPython used in gadgets and robots.

Bitcoin Node with RaspiBlitz

Make the Bitcoin network bigger with a Pi and a large storage device.

You're not going to get rich mining Bitcoin on a Raspberry Pi. Even with dedicated ASIC mining hardware, it's hard to compete with industrial operations in countries with subsidised electricity supplies. It's the same for other cryptocurrencies too – see www.tomshardware.com/uk/how-to/mine-cryptocurrency-raspberry-pi.

Yet you can still use RaspiBlitz to turn your Pi into a full Bitcoin node and store your bitcoins locally – you're essentially self-sovereign as you haven't entrusted

your keys to others and you aren't relying on other nodes to supply information. To quote the RaspiBlitz manual: "Not your node, not your rules".

Put some storage in place

Running a full node involves regularly syncing the Bitcoin blockchain, which at present is 350GB and growing, so you'll need some large external storage – a 1TB or larger external SSD. Ideally, you want your node to be online all the time, but if you have a fast internet connection, it's

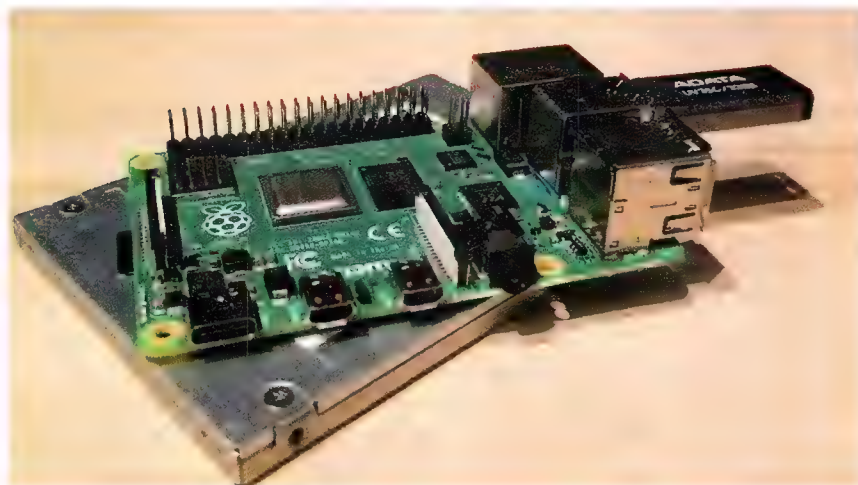
easy enough to catch up after some downtime. Bitcoin nodes verify new transactions before sending them to miners, and record new blocks as they're mined, so they can't do anything useful until they're synced.

Using a 3.5-inch LCD touch display to run RaspiBlitz is recommended but you can also run it headless. It's also advised to use a heatsink to avoid damage from overheating. Fetch the SD card image from <https://github.com/rootzoll/raspi blitz>, write it to an SD card (minimum 16GB), and use it to boot your Pi. If you have the recommended XPT2046 display, this will be used automatically and will display the device's IP address. If not you can use a tool such as Nmap to get this information and then connect from another device with, say

```
$ ssh admin@192.168.178.47
```

and using the default `raspi blitz` password.

The setup wizard will walk you through setting up passwords, storage, and syncing the blockchain. Once you log in again you'll be presented with the options screen where you can tweak settings and set up as a node on the Lightning Network (see below). Note that for others to connect to your node, you'll need to open port 8333 on your router (and use a dynamic DNS service if you don't have a static IP at home). For Lightning, you'll also need ports 9735, 10009 and 8080 to be open. You can also open a command prompt from the main menu, but don't be tempted to run `apt update` or such. There are instructions for updating RaspiBlitz on the project page and if you don't follow them there will be tears.



You'd be hard pushed to find a large-enough SD card to store the blockchain, so get yourself an external SSD.

THE LIGHTNING SEEDS

Besides running a Bitcoin node, RaspiBlitz enables you to run a node on the "layer 2" Lightning network. The Lightning network permits Bitcoin transactions to take place off the main blockchain so they can be confirmed instantly rather than subject to the median six-minute confirmation time that is part of the Bitcoin fabric.

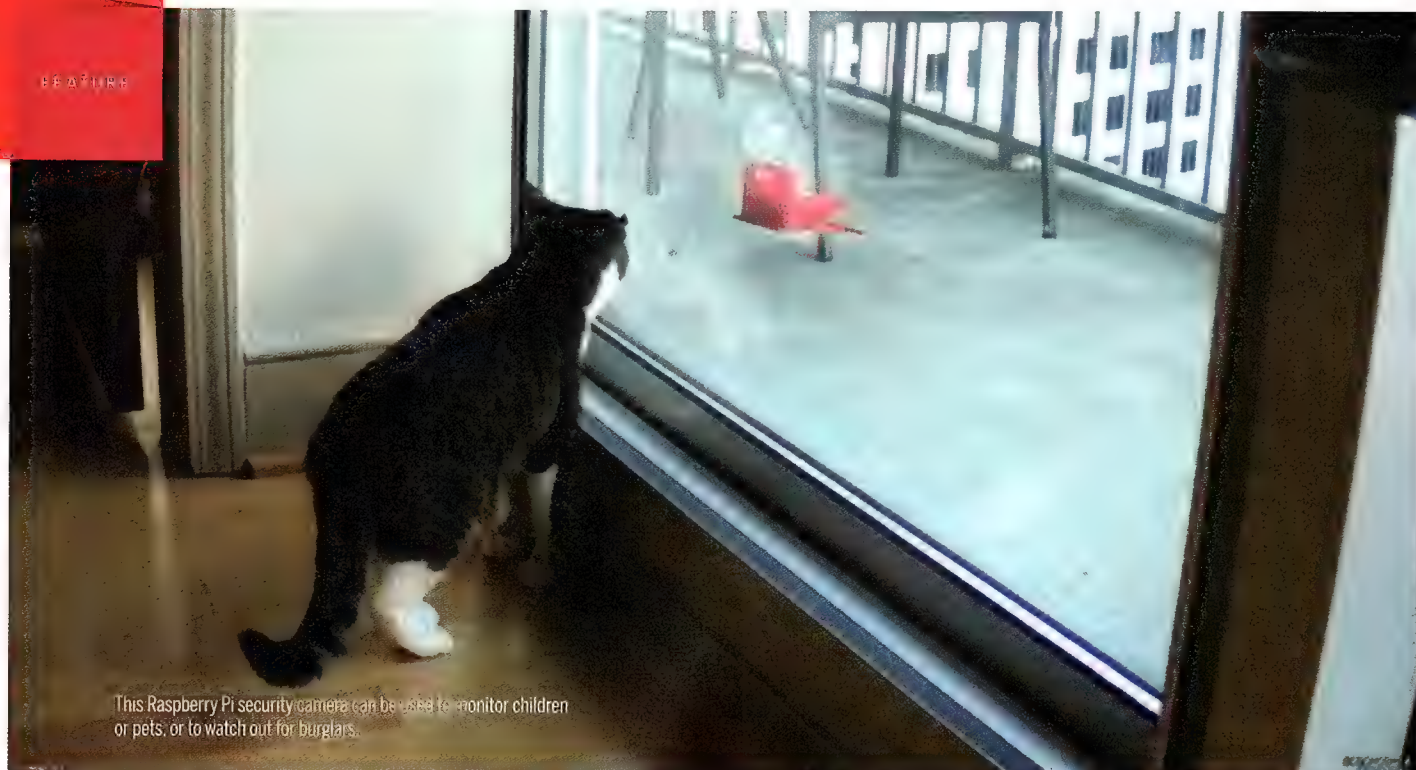
It's possible to generate some income by running a Lightning node but not necessarily something you should jump into unaware. Since the network lacks the democratic (but lengthy) consensus mechanism of the main network, you could operate a rogue node and attempt to

double-spend a transaction or even cheat the system. However, there are omniscient searching watchtower services that detect improper operating Lightning nodes and penalise them.

Lightning nodes are connected to Bitcoin wallets, and these must contain sufficient funds to cover any off-chain business. A malfeasant is detected, a no-doubt justice transaction is initiated funds are docked. If your node accidentally goes offline while a channel is open, then you may initially lose funds, but these can be reclaimed (subject to both party's approval) once your node is back online.



You can use Onion (Tor) routing to keep the IP address of your Lightning Node a secret.



This Raspberry Pi security camera can be used to monitor children or pets, or to watch out for burglars.

MotionEyeOS

Build your own motion-triggered home security camera.

You'll need

• Raspberry Pi 3B+, 4 or Pi Zero W • 8GB (or larger) microSD card • Raspberry Pi Cam, HQ Camera, Infrared Camera or webcam • Monitor/power supply/HDMI cable

Home security camera systems have exploded in popularity and decreased in price over the past few years. Yet there are some drawbacks: vendors often charge a monthly fee to store your data; and you might not want to share video and photos from inside your home with a third party.

MotionEyeOS is a distro that enables you to turn a Raspberry Pi with a camera into a home video-monitoring system, where the photos and videos can either stay on your device (and home network) or, if you choose, be uploaded automatically to a cloud-storage service such as Google Drive or Dropbox.

Here, we'll show you how to set up a Raspberry Pi security camera with MotionEyeOS. This software works with almost any Raspberry Pi (connected to the internet) and most webcams or Pi cameras too. There's no fancy coding in this project; it just works.

Download the latest version of MotionEyeOS corresponding to the model

of Pi you're using from <https://github.com/ccrisan/motioneyeos/releases> and write it to the SD card. When the process completes, physically remove and then reinsert your microSD card. We do this because the software automatically ejects the microSD card when the process completes, but we need to add one file before the next step.

Create a file named `wpa_supplicant.conf` with the this text, replacing "YOUR_NETWORK_NAME" and "YOUR_NETWORK_PASSWORD" with your details:

```
country=gb
update_config=1
ctrl_interface=/var/run/wpa_supplicant
network={
    scan_ssid=1
    ssid="YOUR_NETWORK_NAME"
    psk="YOUR_NETWORK_PASSWORD"
}
```

Save the file, eject the SD card and insert it into your Pi. Connect your camera, monitor and power supply to your Raspberry Pi and power up. If you have a monitor connected your Pi's internal IP address will be displayed on the Pi screen. Alternatively, you can find this out from Nmap or your router's configuration page.

Enter your internal IP address into a browser window and MotionEye should start streaming.

Configuring MotionEye

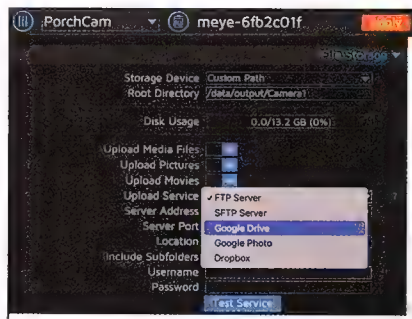
Click the Profile icon within your browser menu to pull up the Login screen. Log in using the default credentials (username is

admin, the password field should be blank). Select your Time Zone from the menu in Time Zone. Click Apply. MotionEye will reboot which will take a few minutes. This is important as each photo and video is timestamped.

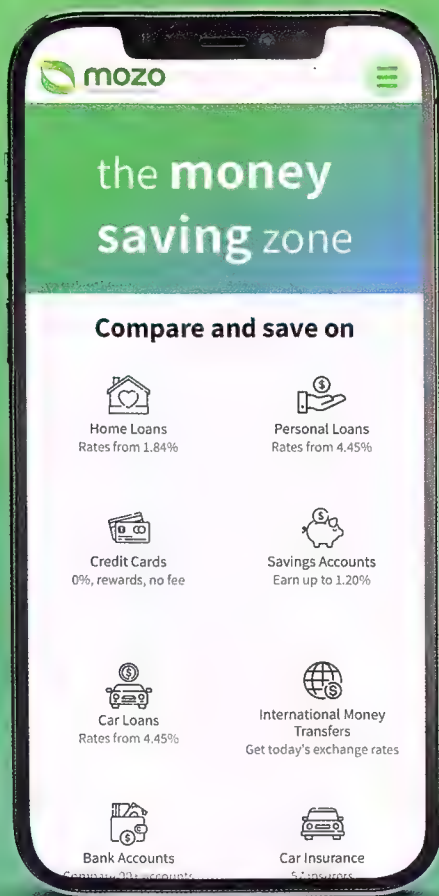
The Frame Change Threshold setting determines the proportion of pixels that change before recording starts. Set your percentage low enough to pick up the movement you're tracking, but high enough to avoid recording a passing cloud. Start with the default four percent Frame Change Threshold and then move up until you reach your optimal setting. Click the down arrow to the right of Still Images to reveal extra settings. Do the same for Movies. Set Capture Mode and Recording Mode to Motion Triggered and choose a period to preserve both. A week is reasonable if you're working with an 8GB card. Click Apply to save changes.

Set your Camera Name, Video Resolution, and other options in the Video Device section. Click Apply to save changes. On the live feed view, you'll see buttons for viewing saved images and video.

In the current setup, this media won't leave your local network. But if you're okay having your media in the cloud, it's easy to set MotionEyeOS to upload to Google Drive or DropBox. If you want to enable remote access to your Pi security cam, you'll need to configure port forwarding on your router. If you do this, there are official iOS and Android apps so you can check your home when you're out. ■



Don't rely too much on SD cards for storage. Cloud saves will make files easier to access too.



Compare over 1800 loans, savings & insurance products

mozo.com.au



mozo
The money saving zone



Even the budget Radeon 6600XT launched at a higher price than planned thanks to supply chain issues with manufacturing components.

System news

AMD delivered an impressive launch, but Mark Williams is still eager for Intel's splash.

The graphics card market continues to resist efforts to bring prices back under control. The lowest option in Nvidia's latest RTX 3000 series line-up, the RTX 3060, starts locally at around \$1,050 and skyrockets from there up to \$1,350 and beyond. By comparison, in mid-2019, the then-new RTX 2060 started at roughly \$560 and only cost around \$650 for the top tier versions. The same class of graphics card has doubled what it used to be – it's crazy!

At least things have improved to the point where most SKUs of any GPU are now actually in stock and available if you want to pony up for it.

We've seen over the past months that prices have dropped globally, as revealed by German website *3DCenter*, but the drop has plateaued off lately to beginning-of-2021 levels and is starting to gradually climb again. So, if stock is available, why haven't prices dropped?

For the most part, it's because they simply cost more to produce

currently. Many of the supply chains that feed into making graphics cards are still under high strain globally, with raw materials and componentry all having seen price mark ups being passed on to the customer in the final product.

For example, GDDR6 prices have doubled according to AMD, which is one of the reasons its RX 6600XT launch price was adjusted upwards. When 8GB of GDDR6 goes from just \$50 up to over \$110, that needs to get passed along to the customer.

And with all chip foundries pushing out wafers as fast as they can, allocation is going to come at a premium and thus cost more to the end user. In fact, TSMC recently announced that they will be raising manufacturing costs by ten percent for leading edge nodes like 5nm and by twenty percent for older nodes, the single biggest price jump in a decade. This is in part to help pay for the ever-increasing R&D costs of advancing its manufacturing technologies, but also to help offset the one



MARK WILLIAMS
Mark is an IT professional with a strong interest in voiding warranties.

hundred billion dollars in spending it'll be doing over the next three years expanding its operations.

AMD did well with its recent RX 6600XT launch. It aimed to have near MSRP pricing and high stock levels at launch, and low and behold it basically did just that. Pricing was good on launch day with some selling for as little as \$650 and stocks lasted for several days before the initial allocation dried up, which these days is quite an achievement. With things having settled and demand plus Australian dollar pressures causing prices to rise to around \$750, considering it offers roughly 10 percent more performance than an RTX 3060 while being \$300 or more cheaper, the RX 6600XT is a bargain and quite obviously the superior bang for your buck choice currently.

Of course, there's nothing like competition in a market to force prices lower and with Intel's new discrete GPUs around the corner, having a third option that pulls from an entirely separate foundry on the market should do wonders for prices and availability. Not to mention Intel will be wanting to keep their graphics cards intentionally priced low to help them gain initial market share in the discrete segment. While Intel isn't expected to provide offerings that compete at the top end in its first generation, arguably it will be entering the scene when it is most needed in the mid to lower tier product ranges. Due to hit the market early next year, they can't come soon enough. ■

SHOP TALK

How has the RX 6600XT launch been? Are stocks and prices holding up well to demand?

Jaimie, Leader Computers: "We keep getting told by the distributors that supply is about to get very tight, very soon, on HDDs and SSDs, although we haven't seen it trickle through yet. At the moment we can get all the stock as usual, and the price hasn't risen yet. I think it will certainly impact us, but it is probably a delayed impact while the distributors move through the current stock they have. Then we will likely see shortages as well as price hikes I imagine."

Market snapshot

A sampling of PC systems available this month.



\$3,499 – tinyurl.com/APC499MWV

MWAVE THERMALTAKE RAPTURE PRO V2

What should be a mid-tier gaming rig is now going for top tier money, which unfortunately is just a sign of the current market. Ignoring the price, this is a very nicely balanced system. The best six-core CPU available is paired with a solid GPU that is a little lacking in the VRAM department, so don't match it with a 4K monitor. But it will dominate at 1440p or ultra-wide resolutions. The speedy RAM will keep the CPU happily fed. The 500GB SSD is a little disappointing. It would've been better to remove the HDD and increase that to 1TB, but in this configuration at least you've got plenty of storage. A solid gaming rig for serious gamers.

CPU: AMD Ryzen 5 5600X **Cooler:** Thermaltake RC240 ARGB AIO **Motherboard:** Asus TUF Gaming B550M-Plus **Graphics:** Asus GeForce RTX 3070 8GB **Memory:** 16GB Thermaltake ToughRAM RGB DDR4 3600MHz **Storage:** 500GB SSD + 2TB HDD **Power Supply:** Thermaltake Toughpower Grand Sync RGB 650W **Case:** Thermaltake View 51 ARGB



\$3,194 – tinyurl.com/APC499JWC

JW COMPUTERS FLARE 6700 XT

Coming in a little cheaper than the Mwave system, this rig has some benefits worthy of your consideration. First is the eight-core CPU, which will be handy for those that like to dabble in productivity work. And secondly there's the 1TB SSD, which is nice and roomy for multiple modern big AAA games.

The downside is that the GPU is a tier lower, matching RTX 3060 Ti performance levels, the 6700 XT has 12GB of VRAM, which should help it age better over time as texture sizes in newer games increase. The PSU has solid capacity (given that it's SFX) and the highly configurable O11 Dynamic Mini chassis will make it easy should upgrades be necessary down the track. For those that know what they want, this could be a great starting point.

CPU: Intel Core i7 11700K **Cooler:** MSI MAG Core Liquid 240R ARGB **Motherboard:** Intel Z590 Chipset **Graphics:** Radeon RX 6700 XT 12GB **Memory:** 16GB DDR4 3600MHz RGB **Storage:** WD Black 1TB NVME M.2 Gen4 SSD **Power Supply:** 750W SFX **Case:** Lian Li PC-O11 Dynamic Mini



\$12,999 – tinyurl.com/APC499AFT

AFTERSHOCK PC INTEL GAMER DAYS EXTREME BUNDLE

As the most expensive PC we've ever featured you'd think it'd have the best possible components.

The bespoke custom hard-line water-cooling loop with full fascia distribution block certainly blinds you to the price for a few moments, before you realise you're not getting the best of the best on the market right now. Sure, it has one of Intel's best CPUs and AMD's best GPU inside which will certainly give you high FPS at 4K, but neither are the absolute best on the market right now. Those titles fall to the Ryzen 9 5950X and RTX 3090. To not have either at this price is a bit of a letdown.

CPU: Intel Core i9-11900KF **Cooler:** Ultralabs Custom Open Waterloop Cooling **Motherboard:** Gigabyte Z590 Aorus Xtreme WaterForce **Graphics:** Gigabyte 6900XT Aorus Xtreme Waterforce 16GB **Memory:** 32GB Aorus 4400MHz RGB **Storage:** 1TB Gen4 Aorus M.2 NVME, Raid 0, 4TB Gen4 Aorus M.2 NVME **Power Supply:** 850W **Case:** Lian Li O11D XL

\$11,515 – tinyurl.com/APC499PLE

PLE COMPUTERS NEON

What a stunner. Like the Aftershock system this features a very similar spec sheet, though this has the full "K" CPU version so the IGP will offer you QuickSync support should you need it. The 32GB of 3200MHz RAM is a tad slow for this price point and the 1TB SSD and 850W power supply both feel small given the system cost. But while this is some \$1,500 cheaper than the Aftershock rig, it's still a very expensive system without the very best on the market components. Like the Aftershock system you're mainly paying for the custom hard-line water-cooling loop and the gorgeous case interior setup, including RGB and sleeved PSU cables to match the neon theme. While it's a very impressive system in its own right, only buy this as an art piece to show off to your millionaire celebrity friends – just don't brag that it's the best system money can buy.

CPU: Intel Core i9 11900K **Cooler:** PLE Custom Watercooling CPU + GPU (Rigid Tubing) **Motherboard:** Gigabyte Z590 Aorus Xtreme WaterForce **Graphics:** Gigabyte Radeon RX 6900 XT Xtreme WaterForce WB 16GB **Memory:** Corsair 32GB DDR4 Vengeance RGB Pro SL C16 3200MHz **Storage:** Seagate FireCuda 530 PCIe 4.0 1TB M.2 SSD, Seagate BarraCuda 2TB 7200RPM HDD **Power Supply:** Corsair RM850x V2 850W **Case:** Jonsbo TR03-G Silver



PC BUILDER

Budget

A perfect balance between price and performance.

So, the time has finally come, we can upgrade our budget AMD's CPU. We have opted for the Ryzen 3 1200 CPU and seeing it in stock on Amazon.com was a joy, to say the least. The Ryzen 3 3100 would have been way better, but it's more than double the price of the Ryzen 3 1200. At the same price as our previous CPU, we can now double our cores, but unfortunately it won't double our threads just yet. Hopefully, in time, the Ryzen 3 3100 will slip into the budget build and make this a great full package.

Also in our AMD build, we hunted around and found some similarly-priced RAM sticks with a slight speed increase, @ 3200MHz instead of @ 3000MHz. Crucial Ballistix 16GB (2x 8GB) DDR4-3200 CL16 Memory is a bit of a mouthful, but it will help us get that extra little bit of speed and future-proof it slightly. At the same price we can't complain either. These changes help us improve our build while still not pushing the budget too far. When

you are building your own custom rig, it's worth its weight in gold to look around. Yes, it can be time-consuming but, eventually, you'll get to know the market like the back of your hand.

Little changes here and there can soon equate to a decent saving that you can spend more appropriately elsewhere. However, we have chosen the same RAM sticks as in the AMD build. For exactly the same price as last issue's RAM (Team T-Force Vulcan Z) we get the same configuration of 2x

8GB, but increase the speed from 3000MHz to 3200MHz. That makes sense, right?

The problem here for both builds is that GPUs are still awkward to get hold of. Prices have dropped slightly, but cards that you see floating around second-hand markets are still sky-high compared with the RRP's and aren't always the best. A lot of these may have been used for cryptocurrency mining, so not exactly the best decision.



AMD INGREDIENTS

PART		PRICE
CASE	Corsair 4000D Airflow	\$130
PSU	500W EVGA BR 80+ Bronze	\$90
M/BOARD	MSI Pro B450 Pro-M2 MAX	\$90
CPU	AMD Ryzen 3 1200 NEW	\$140
GPU	AMD Radeon RX 6700 XT 12GB	\$1,100
RAM	16GB (2x8GB) Crucial Ballistix @ 3200MHz NEW	\$140
SSD	256GB Adata SX8200 Pro M.2 NVMe	\$70
HDD	1TB WD Blue 1TB 7200	\$60
OS	Windows 10 Home 64-bit OEM	\$60
PRICE		\$1,880

INTEL INGREDIENTS

PART		PRICE
CASE	Corsair 4000D Airflow	\$130
PSU	500W EVGA BR 80+ Bronze	\$90
M/BOARD	Gigabyte B460M DS3H V2	\$140
CPU	Intel Core i3-10100	\$190
GPU	Nvidia GeForce RTX 3060 12GB	\$1,200
RAM	16GB (2x8GB) Crucial Ballistix @ 3200MHz NEW	\$140
SSD	256GB Adata SX8200 M.2 NVMe PCIe 3.0 NEW	\$70
HDD	1TB WD Blue 1TB 7200	\$60
OS	Windows 10 Home 64-bit OEM	\$60
PRICE		\$2,080



PC BUILDER

Mid-range

More CPU cores and a nice yet insanely over-priced GPU.

AMD's Ryzen 5 5600X still seems to be the best bet for our mid-range CPU. This six-core processor with 12 threads is a great choice and, thankfully, there's no price differential. We have opted for the Wi-Fi version of the same motherboard. However, a BIOS update may need to be performed for Vermeer CPUs to be compatible.

We all know this can be a pain to do and you need an older CPU at hand that is supported by older BIOS versions.

Other than the change in

motherboards, our mid-range AMD system hasn't seen any other changes. A second-hand Nvidia GeForce RTX 3070 is still pretty expensive but Australian retailers generally have stock back for most graphics cards, though still at a price premium. G.Skill Ripjaws V Series RAM sticks are still a great pick, and with a good speed, @3600MHz, they fit this build nicely.

For our CPU, we considered changing again to the i7-11700F counterpart. This is still more readily available, however,

we stuck to our guns, as the chosen i7-11700K offers better performance and overclocking potential. The F variant also has no integrated graphics, but if you aren't put off by that, it's still a great CPU, especially now it's cheaper.

We also opted for the GA version of last issue's PSU as it's virtually the same unit but with more connectors. Last time, we added Corsair's Force MP600 M.2 SSD, which was a great addition.

AMD INGREDIENTS

PART		PRICE
CASE	Lian Li PC-O11-Dynamic	\$210
PSU	650W Fractal Design Ion Gold	\$140
M/BOARD	Asus AM4 TUF Gaming X570 -Plus WiFi NEW	\$330
CPU	AMD Ryzen 5 5600X	\$430
COOLER	240mm Cooler Master Masterliquid ML240L RGB	\$100
GPU	Nvidia GeForce RTX 3070 8GB	\$1,700
RAM	16GB (2x 8GB) G.Skill Ripjaws V Series @ 3,600MHz	\$140
SSD	500GB PNY XLR8 CS3040 M.2 PCIe 4.0	\$140
HDD	1TB WD Blue 1TB 7200	\$60
OS	Windows 10 Home 64-bit OEM	\$60
PRICE		\$3,310

INTEL INGREDIENTS

PART		PRICE
CASE	Lian Li PC-O11-Dynamic	\$210
PSU	650W EVGA SuperNOVA 650 GA NEW	\$140
M/BOARD	Asrock Z590M PRO4	\$200
CPU	Intel Core i7-11700K	\$570
COOLER	Enermax Liqmax III 240 RGB	\$90
GPU	AMD Radeon RX 6800 XT 16GB	\$2,200
RAM	16GB (2x 8GB) Silicon Power XPOWER Turbine @ 3,600MHz	\$85
SSD	500GB Corsair Force MP600 M.2 PCIe 4.0	\$150
HDD	1TB WD Blue 1TB 7200	\$60
OS	Windows 10 Home 64-bit OEM	\$60
PRICE		\$3,765



PC BUILDER

Turbo

Now we're cooking.

Yes, here we are again talking about GPUs in a negative way. It seems such a shame but this elephant in the room doesn't seem to be going away any time soon. The good news is that graphics cards have returned to stock across most Australian resellers – though many models are still out of stock – and worse, the prices are still way above RRP. We can't recommend paying for a second-hand market GPU, as the prices are still relatively high and you can never guarantee the quality you are getting.

This time around, we have swapped out the Patriot Viper Steel DDR4 RAM

on the AMD build for some new sticks. G.Skill Ripjaws V sticks offer faster speeds at 4000MHz and are still the same 2x 16GB configuration. The central processing chip stays the same here. When looking around for a similar price, the Ryzen 7 5800X CPU is still our best bet. With eight cores, 16 threads, and a 3.8GHz base clock, it's a great gaming CPU.

With some cuts in the budget, we upgraded our AIO to Corsair's iCUE H150i Elite Capellix 75 cooler. It's a great all-around 360mm AIO.

On the Intel rig the beautiful i9-

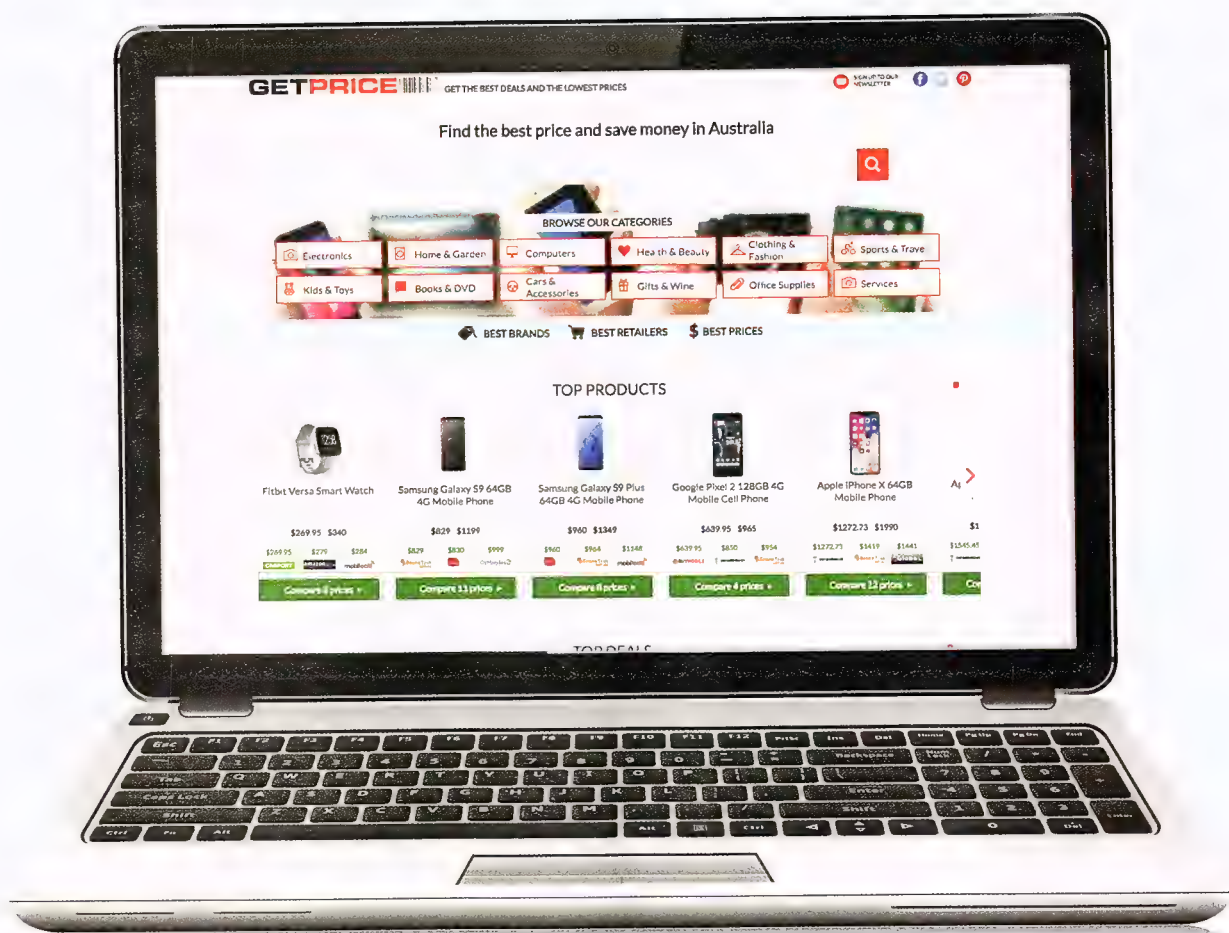
11900K remains on the turbo build. We don't think this will be swapped out any time soon and is a no-brainer for the Intel system. The same RAM was also added to this build, as seen in the AMD turbomachine. As this RAM is cheaper than the previous sticks, it makes sense to pick the same 2x 16GB configuration just with increased speeds. Other than that, the Intel build has no changes, just a decrease in prices across the board, apart from the GPU unfortunately. On the whole, though, it's a positive direction for the market. ■

AMD INGREDIENTS

PART		PRICE
CASE	Phanteks Enthoo Pro 2 Tempered Glass	\$220
PSU	750W NZXT C750 80+ Gold	\$140
M/BOARD	MSI MPG X570 Gaming Edge Wi-Fi	\$240
CPU	AMD Ryzen 7 5800X	\$650
COOLER	Corsair iCUE H150i ELITE CAPELLIX AIO 360mm NEW	\$260
GPU	Nvidia GeForce RTX 3080 10GB	\$2,600
RAM	32GB (2 x 16GB) G.Skill Ripjaws V @ 4000 NEW	\$250
SSD	1TB Samsung 980 Pro M.2 PCIe 4.0	\$270
HDD	6TB Western Digital Blue	\$240
OS	Windows 10 Home 64-bit OEM	\$60
PRICE		\$4,930

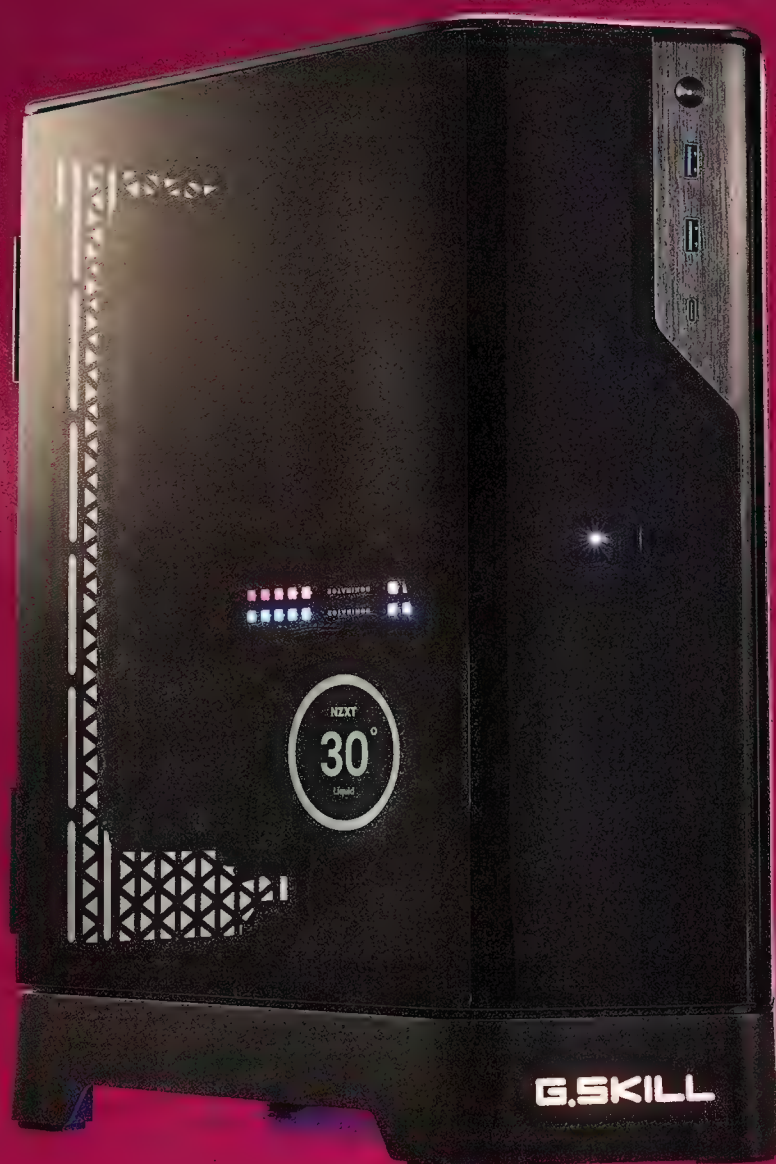
INTEL INGREDIENTS

PART		PRICE
CASE	Phanteks Enthoo Pro 2 Tempered Glass	\$220
PSU	750W EVGA SuperNOVA 750 G5	\$160
M/BOARD	ASRock Z590 Steel Legend Wi-Fi	\$300
CPU	Intel Core i9-11900K	\$850
COOLER	MSI MAG CoreLiquid 360R AIO	\$170
GPU	AMD Radeon RX 6900 XT 16GB	\$2,400
RAM	32GB (2 x 16GB) G.Skill Ripjaws V @ 4000 NEW	\$250
SSD	1TB Gigabyte Aorus Gen4 7000s M.2 PCIe 4.0	\$250
HDD	6TB Western Digital Blue	\$240
OS	Windows 10 Home 64-bit OEM	\$60
PRICE		\$4,900



Find the best prices
on the latest tech.
www.getprice.com.au

GETPRICE  TM



PC BUILDER MASTERCLASS

Length of time: 2-3 Hours Level Of Difficulty: Medium

High End ITX Art

G.Skills to Pay The G.Bills

It's fair to say that when we first set eyes upon the G.Skill Z5i, we were impressed.

On first appearance, the Z5i is an exceptionally beautiful chassis, complete with an aluminum frame, curved tempered glass panels and baked in RGB lighting, including a neat little underglow that makes us think back to the glory days (if you can call them that) right at the start of the *Fast and Furious* franchise.

We were lucky enough to get an early sample just as it was announced, but at the time of writing the Australian RRP wasn't finalised.

Still, it got us thinking about what exactly to build inside this thing? We wanted something a little special, a little different, and a bit more high-end. So we decided to grab a hold of our AMD Radeon RX 6800 XT, gather together a few choice parts from manufacturers

across the globe, and set to work, with the aim of building a fantastic ITX work of art. Or at least, that was the plan.

Of course, getting parts right now is a challenge and something that doesn't seem to be changing any time soon. So, we appreciate it's not exactly realistic to build this rig, not least when a GPU is still being listed at over double its RRP price, and for a stock reference card at that. Frustrating? Very. ZAK STOREY

As we mentioned, this build was and is all about that chassis. The PC, and hardware itself inside, are relatively insignificant in the grand scheme of things right now, so consider this more an exercise on peripherals and case-building, or an in-depth review, rather than a “we built this for X, look how it performs” kind of scenario. If you’re interested in flashy-looking ITX cases that can sit proudly on your desktop, or how G.Skill’s first attempt at case design went, it’s definitely the build-it for you.

That aside, the hardware contained inside, at reasonable prices, would make a fairly chunky gaming PC, or a mid-range entry point for anyone looking to get a foothold into video-editing for sure. The main thing that decided our picks for this issue though? Lighting. The Z5i, being the showcase chassis it is, demands some top-quality hardware, and to that end, we went into this with several components in mind.

For our RAM, Dominator Platinum RGBs from Corsair were the logical choice, the capelix LEDs situated in those things are insanely bright, and once configured properly, can light up a room. Our CPU cooler is the digital display equipped Nzxt Kraken Z53 240mm AIO (this case supports up to a 280mm AIO, which we would recommend you go for). And lastly, our GPU is the mildly flashy Radeon RX 6800 XT from AMD.

Originally, we intended to go for one of Zotac’s GeForce RTX 3080 Ti’s complete with over-the-top ridiculous LED lighting (as Zotac is one of the best at that), but sadly the card arrived a day after our photo shoot. nonsensical for that card.

PART		STREET PRICE
Case	G.Skill Z5i ITX Tower	\$TBA
Motherboard	MSI MPG B560I Gaming Edge WiFi	\$245
CPU	Intel Core i5-11600K	\$420
GPU	AMD Radeon RX 6800 XT	\$2,000
Memory	32GB (2x16GB) Corsair Dominator Platinum RGB @ 3200 MHz	\$360
PSU	750W Corsair SF 750 80+ Platinum	\$230
Primary Storage	1TB Corsair MP600 Force PCIe 4.0 M.2	\$260
CPU Cooler	Nzxt Kraken Z53 240mm AIO	\$340
OS	Windows 10 Home 64-bit OEM	\$60
Total (not including case)		\$3,915



The two side panels, once open, can be lifted off their hinges with relative ease, then placed in the chassis box, which comes with some lovely foam packaging.

01 Prodigal Chassis

And here we have the G.Skill Z5i, unboxed and ready for building in. We'll list a few key specs here; it has curved tempered glass panels on both sides that swing open, with some hefty magnets behind them. It supports up to a 280mm radiator (and two either 120 or 140mm fans), and can theoretically support three-slot graphics cards up to 33cm or 23cm with a 3.5-inch HDD installed. It can also support CPU cooling up to 7cm, has multiple support for drives (but we'd recommend you only use M.2 drives), and fits SFX power supplies only, although again the smaller the PSU you can get (as in physical size), the better.

02 Chassis Teardown

First up as always, we try and remove as many of the panels as we can. This just helps keep them safe, stops you from potentially getting scratches on them, and decreases the weight of the whole thing too, making it easier to shuffle and move around when building and installing hardware. The two side panels, once open, can be lifted off their hinges with relative ease, then placed in the chassis box, which comes with some lovely foam packaging. Then once they're out of the way, you can remove the top-most mesh filter, simply by pushing up from underneath.

That's actually a pretty neat design for this kind of case, as with the way the GPU and motherboard are compartmentalized, means hot air should go straight up, pretty much in a chimney style design, which is ideal for efficient heat dissipation. You'll spot that there are a few cables tied down as well, including the front I/O cables. It's worth leaving these in place for the time being while we work on other parts of the build.



03 CPU installation

Rumor has it that AMD intends to go with an LGA socket on its next generation of Ryzen processors, in a similar manner to its Threadripper chips. So, those who are less familiar with Intel's way of doing things might want to brush up on their LGA installation tips. There's no guarantee the AMD socket will look identical to the 6000 series (assuming it's called that), but the likelihood is high it'll be similar to Intel.

To install our Intel Core i5-11600K, simply lift the retention arm located on the right of the socket, then raise the securing bracket up (leave the plastic cover on, you're more likely to damage the pins by removing it before the CPU is in). Then carefully place the processor into position, making sure to align the little gold triangle on the bottom left corner, with the triangle on the bottom left of the socket.

It's almost always indicated on the securing bracket we've just raised, and should also be on the motherboard as well, but if not, make sure the writing on the CPU reads left to right, when the motherboard is positioned like this, with the top left of the rear I/O being the top of the motherboard (in this case, where that 8-pin CPU power is, that's the top of the board).

Once in position, carefully lower the securing bracket, making sure to slot it under the Torx screw below the CPU socket, then carefully reinstall the retention arm back down in place. The plastic cover will pop off. If you can, we recommend putting it to one side (either in the motherboard box or CPU box) in case you need it later.

If you end up with a dud motherboard or processor after troubleshooting, most manufacturers or e-sellers will want you to return the parts for their own testing. Ensuring the CPU socket (for an LGA board) is undamaged and protected from any issues during transit is vital to making sure you observe the warranty and can get a refund or a new board, which is why it's handy to keep the plastic cover somewhere safe.

To re-install the cover, once the CPU is removed, we recommend lifting the bracket up, and carefully installing the cover back on it like that, before securing the bracket back down, so you stay away from the pins as best you can. The bracket itself has little plastic notches that will lock it in position. Again orient the writing so it reads from left to right, in alignment with the top of the motherboard.

To install our Intel Core i5-11600K, simply lift the retention arm located on the right of the socket, then raise the securing bracket up (leave the plastic cover on, you're more likely to damage the pins by removing it before the CPU is in)



04 M.2 & AIO bracket

Next up is the CPU cooler's bracket for the CPU block, and the M.2. Open your cooler box, identify the Intel bracket, then find the bag with the correct screws for your socket. Pop the backplate into position underneath the board, then screw each of the four standoffs into position. There's likely to be a bit of sag between the standoffs and the backplate, but that's normal.

Now on to the M.2. In the case of MSI's B560i, remove the two Phillips head screws on the "Edge" heatsink, and lift it off. Then insert your M.2 into the port, making sure to align the notches. In the motherboard box, there should be a bag with an additional M.2 screw in it, secure the drive at the other end with that. Once done, peel off the plastic "laird" sticker/cover located on the thermal pad underneath the heatsink, and reinstall the heatsink.



05 Motherboard in

here we've installed the motherboard into the Z5i chassis. The rear I/O points downward, as does the GPU, so it is going to be fiddly to install your rear I/O devices later, but that's the price we pay for making it look snazzy.

We've held back on installing the memory, as we're already foreseeing problems with cable management, particularly the cooler. When you're building any system, always take your time to look at how the case is designed, where cables need to be routed, what hardware might get in the way, and plan your installation accordingly.

We've also taken the opportunity to install the PCIe riser cable directly into the motherboard. It's a bit tight but installs exactly like a graphics card. It should already be threaded through that cutout in the bottom, just line it up, and push it into the PCIe slot, until it clicks in place.



06 Power supply next?

It's an unusual step for us, but before we've even installed the memory or even the cooler, we decided to go with the power supply next. Now, this isn't something we'd traditionally recommend you do this early on in a build, but hopefully, you'll find out just why it's so important to get this done and out of the way as soon as you can.

How the power supply actually installs in the chassis, however, is something of a mystery, unless you have read the manual beforehand. We'd typically expect a case to be intuitive enough through its design that we wouldn't need to do that, hence we didn't open up the manual at first.

Basically, there is a bracket above the motherboard where the power supply sits in place, from which you can route your cables. That then connects to a passthrough power cable which runs to the bottom of the chassis, where you'd plug your power lead into. However, on first inspection, installing the PSU in a traditional manner just looks insanely difficult, as there's no space for a screwdriver in the back of the chassis. The screws that go into the rear of the power supply, are actually facing that rear ventilated area that your AIO is going to be installed in later. Unless you have a tiny, yet hefty screwdriver, it's not going to happen, and even if you did, it'd be fiddly as heck.

What you need to do is remove the entire bracket from the chassis itself, and then install the power supply to that, outside of the case, before reinserting it and securing it back down in the Z5i again. There are five screws that secure the bracket in place, four of which point out towards the side of the case on the motherboard tray side (meaning easy access for our plucky screwdriver), and another one located on the opposite side, near the top of the chassis, in the domain of the GPU. Remove those, and the bracket can then be removed from the case allowing you to install your PSU without worry. Once that's done, you then reinstall that back into the case, and you're good to go.

Looking at the chassis and the lack of cable management options has prompted us to do all of this earlier. We know we're going to be strapping cables to the frame like nobody's business, and trying to route them as best we can. So front I/O cables, RGB, and PSU cables are going in next.

This is one of the odd things about this chassis and goes back to that point we mentioned earlier about visualising how you think the system is going to be put together. We saw ahead of time that cable management was going to be a nightmare, and so it actively altered how we approached the build. Installing a PSU, threading all the cables through, and handling cable management is usually the final piece of the puzzle. However, in this case, it came pretty much immediately after the motherboard installation because of the situation with the internal cable management. Sad times.



07 Cabling hell

And so it begins... here you can see we've begun our cable runs. We're using a multitude of different cable sets to do this. Our short CPU power wouldn't reach the 8-pin EPS on the board, so we've had to go for a long pro cable. We ran a short 24-pin underneath and round through the passthrough to the motherboard and then strapped those down to the aluminum ventilated divider in the case with our own cable ties – G.Skill doesn't provide any with the chassis. The front I/O is also frustrating to deal with, as it naturally bends out towards the motherboard here. We had to forcefully bend the cables downwards into the "cable management/GPU area" before returning them through the correct passthroughs in the case to get to the correct parts of the motherboard, which was annoying all round. We also pre-threaded the GPU power and an additional SATA power through round the back, in preparation for installing the 6800XT and our Nzxt cooler.



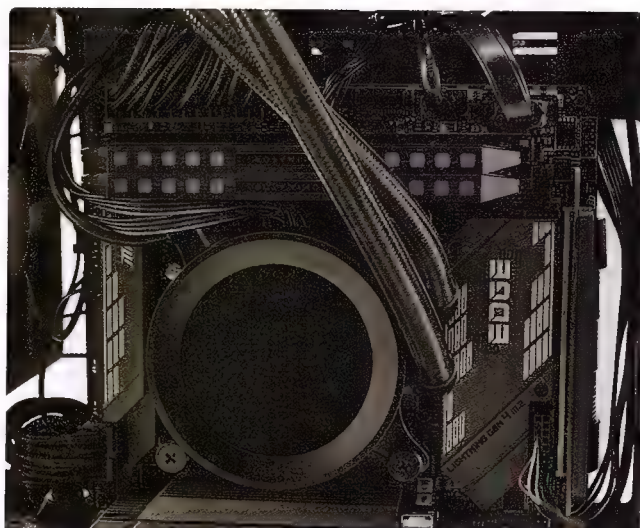
08 But there's a problem...

... and the issue is that our GPU is too tight to the cabling area for us to hide all these cables. The PCIe riser is also secured in position, to allow for three slot cards. So we've detached the PCIe riser cable from the case and let it hang loose (this is how one of our favourite cases, the Hydra Mini, does it). The GPU then sits in those two outside slots, freeing room behind it to tuck all those cables. There's still a problem with this design. Those cables will insulate the backplate of the card, increasing heat there. The card will also conversely heat up those cables. Lastly, the card's tri-fan cooler design is now far closer to that glass side panel than we'd have liked, meaning higher temps too. So although officially this case supports three-slot cards, we'd recommend sticking to two slot cards.



09 Cooling conundrums

Does this look like a mess yet? As someone who prides themselves on clean builds, it feels like a mess. We've installed the 240mm AIO here, it's a finicky process. We secured the CPU block first, ensuring its digital display is in a legible format, then secured the radiator in position at the rear of the chassis. There's so much wasted space here, and the way it's installed looks a bit haphazard. We'd recommend you go for a full-on 280mm if you can. Then it was a case of routing the cables from the CPU pump around to that GPU area. We've strapped them to the interior frame again, and run them to the top of where the cables are, again using cable ties. After that, the DDR4 went in, as it was the easiest way to sort the cables out.



11 Cable calamity

As you can see, things are tight with this cooler. In hindsight, it's not too bad knowing you can rotate the display, but even so, placing the tubing to the right of the block, close to the memory, and the cables to the upper-side of the motherboard would lead to problems with routing as there's so little cable management space here. Securing the block is a straightforward process. Out of the box, it should come with some thermal paste pre-applied to the bottom. If it doesn't, squeeze a small dollop into the middle of the CPU. Then, making sure you have the correct bracket attached to the CPU block, position the block over the stand-offs, and then secure from each corner using the included thumb-screws. Do this a bit at a time, at each corner, by hand, before finally tightening off with a screwdriver (just make sure it's not electric).



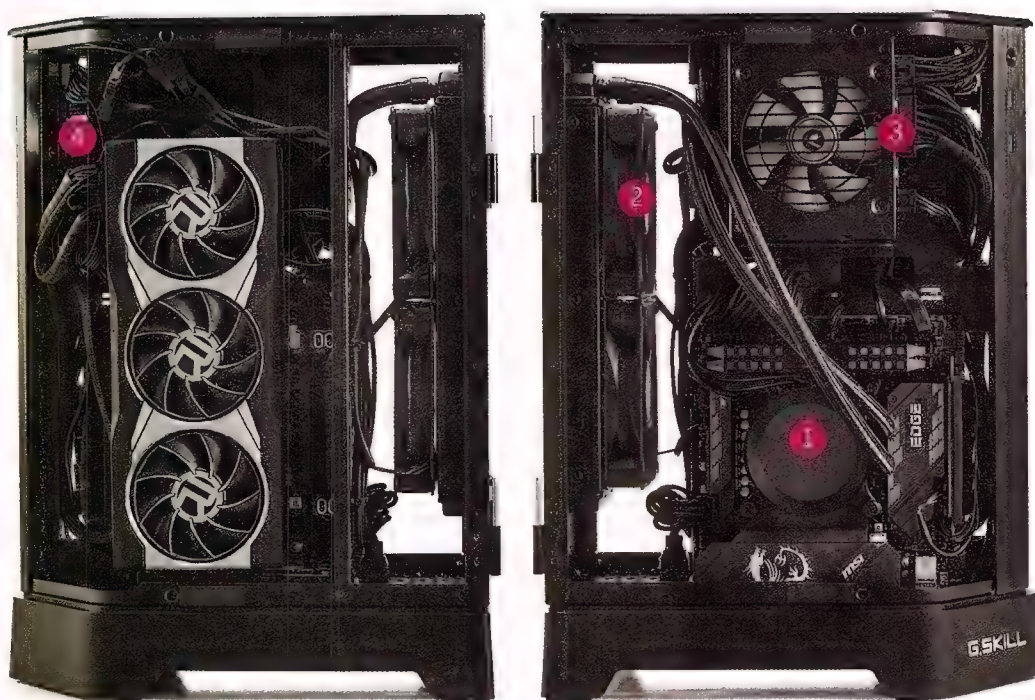
10 Oh no...

So yeah here you can see exactly what we mean about the cable management situation. But unfortunately, there is barely anything we can do. We've actually used some of the velcro straps G.Skill has provided to bundle as many cables together as flat as we can, and then strapped those to the SSD mounting locations in the back of the chassis/motherboard tray. The fan cables and everything cooler-related, and the 8-pin EPS cable, are then strapped to that ventilated mid-plate that separates all three chambers, again using cable ties. We've left the cable tie tails in position for this shot, so you can see exactly where we've done that, but we will cut these off later and hopefully tidy things up a bit.



12 The final piece of the puzzle

And last but not least we get to that trusty GPU. Admittedly, this was a little more difficult to slot in than usual. Attaching that detached PCIe riser into the bottom can be fiddly but once in place, it's easy to position the card and slot it into the two PCIe covers we removed earlier. Then it was simply a case of securing the card down again with the Phillips head screws, plugging in the twin 8-pin PCIe power cables and we were good to go. As you can see, this isn't exactly a clean build. There's no space to hide any cables whatsoever. G. Skill could have thought of a solution to this before releasing the chassis. Even a panel between the motherboard and GPU tray area, that you could run cables down and reattach would be handy. If that means sacrificing some of the case's aesthetics, so be it. Form over function isn't often a recipe for success in something as practical an application as a computer case.



- 1 In hindsight, going for a bigger radiator, and re-orienting the CPU block in software, would have led to a cleaner build here.
- 2 Additionally, some decent RGB fans here would help add some light to the interior of this very smoked-out chassis.
- 3 Custom sleeved cables, cut to a specific length should mitigate the vast majority of your cable management problems, although it'd still be a mess.
- 4 Again, this case really needs some form of cable management solution in the rear. Wedging them all behind the graphics card just isn't a sensible idea.

The conclusion

So, this was an experience, to say the least. At first glance, the G.Skill Z5i is a beautiful-looking thing, with curved panels, brushed aluminum, intuitive lighting, and a fantastic premium feel. But the reality is once you get under the covers and start tinkering with the build, the problems just start to spring up.

Are we happy with this build? In a way yes, it fills the brief of building in this chassis, we got it done, in time, with all the hardware we brought to the table without any swaps. But deep down, it's not one we're proud of. It was frustrating to

deal with, and the lack of consideration for some of the basics of decent case design resonates quite badly, especially when you do this every day.

What would make this case better? This chassis is ITX by design, and I know there is a subset of the PC building community that despises large ITX cases, but if I were designing version 2.0, I'd make it slightly taller and wider. Taller to accommodate a 360mm radiator in the rear, and wider to incorporate a smart form of cable management between the GPU and motherboard tray area.

I'd tidy up the internal layout, especially that rear ventilated aluminum area that the radiator sits in. Giving that a cleaner design with obvious mounting locations for the 280/360mm radiator would be top of my agenda. I'd also add an extra 120mm fan mount located on the back of the interior separator that could feed the GPU with cool air pulled from that radiator location, and then let convection channel the heat up and out. Lastly, I'd drop the smoked effect from the windowed panels. Seeing more of the inside would bring attention to both the GPU and the motherboard, and with that cable-management plate in position between the GPU and motherboard compartment, you'd worry less about cable clutter showing.

Outside of our mission to get a system built in this, however, there's no doubt that, for a first case, G.Skill is on the right track. As we've said in the past, if you want to break into this market, and capture some sales from the likes of Corsair, Phanteks, Nzxt Fractal, and Lian-Li, you need to bring a flawless product to the table. Right now, the Z5i feels like a concept car. It looks awesome, it has that flying steering wheel, and cameras for wing mirrors, but in reality, it's impractical to use, and that's the problem.

We worry that if this case performs poorly, G.Skill will sack off the division and investment entirely, despite all the hard work that's been put in. It needs a version 2.0, because with some slight tweaks to the design and improvements to the airflow, this thing could be an absolute behemoth of a chassis that takes the fight to the big guns.

Are we happy with this build? In a way yes, it fills the brief of building in this chassis, we got it done, in time, with all the hardware we brought to the table without any swaps. But deep down, it's not one we're proud of. It was frustrating to deal with, and the lack of consideration for some of the basics of decent case design resonates quite badly

	Zero-point	High End ITX Art
Cinebench R15 Multi (Index)	2,185	1,723
CrystalDisk QD32 Sequential Read (MB/s)	3,522	5,003
CrystalDisk QD32 Sequential Write (MB/s)	2,988	4,175
Total War: Warhammer II (fps)	48	65
Shadow of the Tomb Raider (fps)	53	71
Red Dead Redemption II (fps)	47	72
Assassin's Creed Valhalla (fps)	38	51

Our zero point consists of an AMD Ryzen 7 3700X, 16GB DDR4 @ 4,133, a Zotac GeForce RTX 3060 Ti 8GB, and a 1TB ADATA XPG Spectrix S40G M.2 PCIe 3.0 SSD. All tests were performed at 4K on the highest graphical profile.

Quick Tips

The problem solvers

The APC team field problems across the spectrum of devices and software. Learn a new trick or fix you can use.

Cooling M.2 drives

I've spent several weeks seeking advice on this topic, but haven't found a spec for the recommended operating range for M.2 drives. All I've found are mixed messages suggesting they do need cooling and they don't need cooling. People have asked the question because they were concerned after seeing high temperatures via monitoring software like Speedfan and CrystalDiskInfo.

There's also a question over whether to purchase cooling with a fan or without. My first attempt was to mistakenly purchase an EZDIY=FAB 5V ARGB M.2 Heatsink for my Gigabyte Z370 HD3 motherboard, which doesn't have a 5V location to plug it in. Instead, I've ordered a Sabrent M.2 2280 Heatsink that has no fan. One final question: do you recommend using thermal compound paste instead of the "thermal pads/tape" they come with?

Dean Johnson

APC Responds: Quite a bit to unpack here. The simple answer is: unless your drive is running consistently 'hot', there's no point in fitting any cooling. But what constitutes 'hot'? First, M.2 drives naturally run hotter – by around 20°C than other installed drives. That's down to where it's installed on the motherboard, typically near the GPU and CPU where temperatures are higher.

M.2 drives supply two temperature sensors – one for the drive itself, and the other for the controller. The latter is consistently hotter than the former, but it's the former you should monitor closely. CrystalDiskInfo and your drive's official tool (such as Samsung Magician) will provide a real-time display of the drive's temperature, but you can monitor both sensors using a tool such as HWiNFO64 (www.hwinfo.com). It provides minimum and maximum figures to go with the current setting.

The M.2 drive's primary sensor on an APC PC reports the drive holding a steady temperature of around 50-55°C, while the controller temperature is around 15°C hotter. This is well within acceptable parameters. You only need to start worrying when the drive reaches 75°C or higher, which could induce thermal throttling, reducing the drive's performance to ensure it stays within temperature limits.

In the vast majority of cases, your drive isn't going to be taxed enough to drive its

temperature to unsafe levels except in limited circumstances, and that's when the throttling should kick in.

The only time you'd want to consider a heatsink is if those idling temperatures are much higher than the comfortable norms observed on our rig. That might indicate airflow issues inside a cramped case, and it's likely your other components will be running hot too. Start by addressing any obvious airflow issues such as poorly stowed cables or clogged-up fans. If your mobo has two M.2 ports of identical spec, you might want to consider moving the drive to the other one to see if runs a little cooler there.

If you're unable to bring down the temperature of the drive without external help, then invest in a heatsink. Note that if you do that, you should look to remove any labeling covering the NANDs to improve heat transfer to the heatsink.

As for applying thermal paste, the overall effect on reducing temperature will be minimal, so APC would recommend sticking with the thermal pads that ship with the heatsink.

Windows boot errors

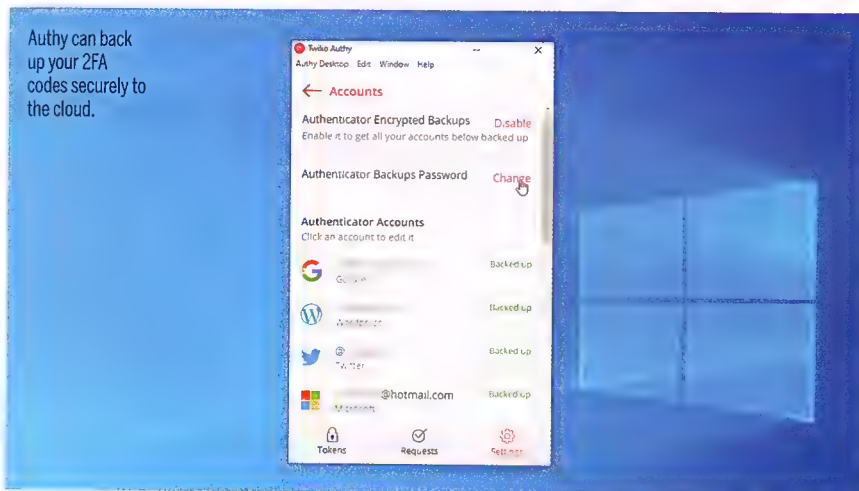
I just built a PC with Asus ROG Strix B550-F gaming mobo, Ryzen 5 5600X CPU, and 1TB M.2 NVMe drive for Windows and apps. It replaced my old overclocked i7-4770K machine and I'm pleased with the results with one major exception: whenever I make an adjustment in the UEFI, Windows won't load, and I receive a message that the \system32\winload.sys file is missing. I then click 'Select an OS', choose the only option (Windows 10), and then after an hour of flashing disk lights and dark

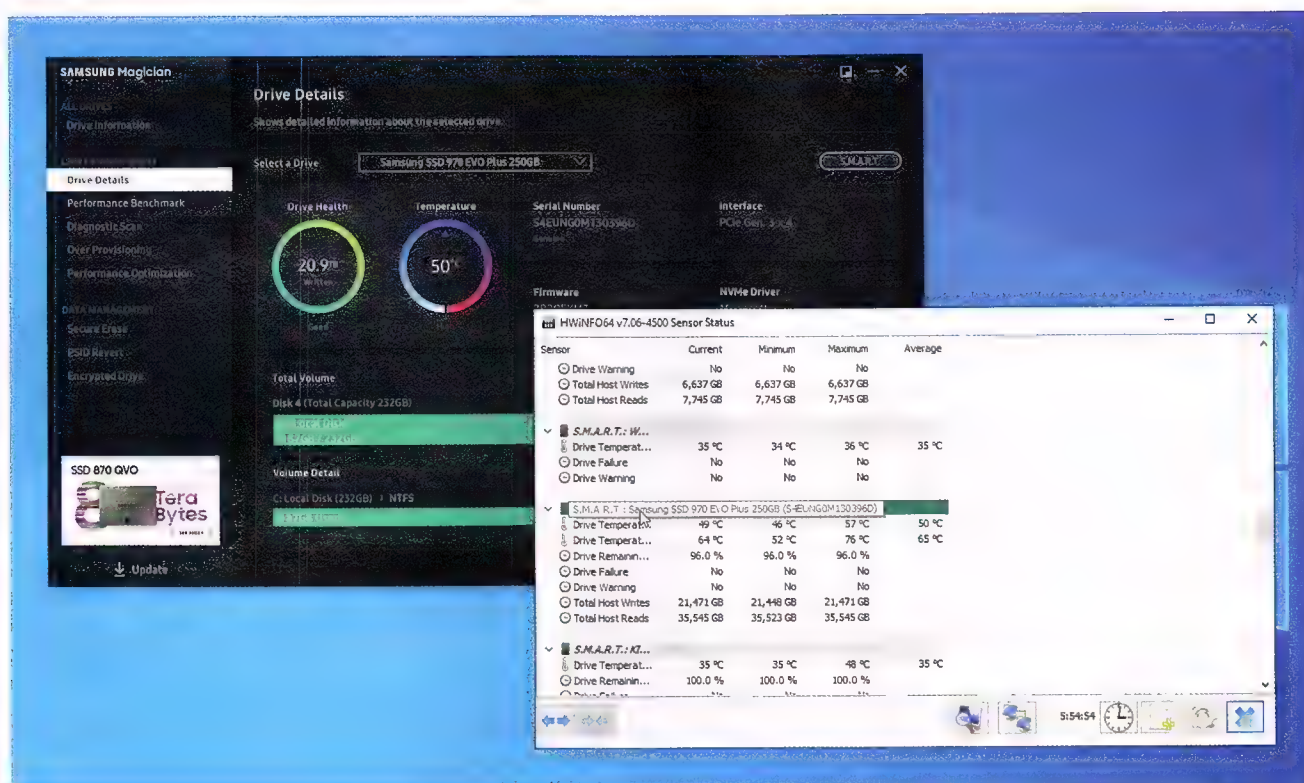
screen Windows finally loads. I run Chkdsk and a few errors are noted as having been repaired. The system then runs okay, but I'm avoiding any BIOS adjustments. If I then go back into the UEFI and verify the M.2 drive is the first boot device, and then exit without saving, the PC boots without problems. Can you explain why this is occurring and if there is anything I can do to make BIOS adjustments reliable?

Philip Wiener

APC Responds: There were lots of questions we wanted answers to before we could suggest anything concrete, but by the time Philip replied to our email, he'd already found – and fixed – the source of his problem. Prior to now, he'd routinely moved his paging file off the system drive – in the case of his new PC, from the M.2 system drive to his 2TB SSD. Restoring the paging file to its original location fixed his problem, and he can now boot into Windows in around 20-30 seconds.

The old trick of moving your paging file to a separate drive to improve performance is pretty much redundant these days with fast M.2 and SSD drives, particularly as Windows is likely to be installed on the fastest drive in your system. To remove any manually set paging file settings, right-click the Start button and choose System, then click 'Advanced system settings' to open the old System Properties Control Panel at the Advanced tab. Click Settings... under Performance, switch to the Advanced tab, and click Change... under 'Virtual memory'. Tick 'Automatically manage paging file size for all drives' and click OK three times, rebooting at the end of the process.





Monitor your M.2 drive temps before plumping for a heatsink.

App Store follow-up

I just read the question from Gerry Exstein about not being able to download the calculator from the Microsoft Store. I have, through my own experience discovered why when you hit 'Get' nothing happens. Unknown to me, Microsoft limits the number of devices a logged-in user can use to access the Store. Officially it's ten, but in many cases it tops out at five. I had this issue when I got my Surface. I struggled for hours then discovered this limit. I went into my MS account to devices and saw only six were registered, including a few I no longer owned. I deleted these redundant devices and was able to use the Store without any problems!

Gregory Watts

APC Responds: They say you can't teach an old editor new tricks, but Gregory's helpful tip proves the opposite, so thanks for sharing it. To see what devices are registered to your account, open your browser and sign in at <https://account.microsoft.com/account>. Click the Devices section to view a list of devices currently connected to your account. Click a redundant entry and you'll see a 'Remove device' option. Click this to free up slots in your Microsoft account and ensure you don't fall foul of the mysteriously malfunctioning Store problem.

Protect 2FA codes

I'm looking into switching on two-step verification for as many online accounts

as possible but am worried about what happens if I lose access to the 2FA codes (say, if my phone was stolen). What options are there for me to securely back up these codes?

Steve Cox

APC Responds: When you come to set up a 2FA code with an online account, you should be given an option to generate a 16-character 'recovery key', which you can use to recover the 2FA code on your new device through a new instance of your 2FA app. You can also generate recovery keys for other purposes too, for example, to recover a Firefox Account when you forget your account password.

You can print this recovery code out or write it down, or copy and paste it somewhere secure, say inside a Bitwarden secure note. Of course, you're trusting Bitwarden's servers to securely host your passwords in this instance.

What can you do if you haven't generated these codes? First, log back into the account in question and navigate to the security section to see if you can generate a new recovery code for the account or 2FA code; if you can then problem solved, but if not, you can disable 2FA for that account, then set up a new 2FA code, making sure that this time you take a copy of your recovery key.

If this seems like too much effort, then another option is to switch your 2FA app to Authy (<https://authy.com>). Authy allows you to sync your recovery codes between as many trusted devices as you

like – phone, tablet, computer (via desktop app), and browsers (via add-ons). And if that's not sufficient, Authy also supports secure backups to the cloud via its servers – generate a strong password and your codes will be online and retrievable should you lose your device. Both sync and backup options are optional and can easily be disabled depending on what method(s) you trust.

TPM restart issue

I read that you were able to help a guy fix his strange shut-down issue and I thought about the intermittent problem I've had with my own system: built around an MSI Z170A GAMING M5 1.0 (BIOS v 1.F0). From the beginning, the machine would go directly to the BIOS whenever I attempted to restart (as opposed to shutting down and starting up manually). I exit without saving and the machine boots fine 100 percent of the time. Occasionally for Windows Update, the machine will restart properly, but not for any other program or if I try to restart from the Start menu. I've found nothing in my searches. Can you help?

Zach Pulkin

APC Responds: Before we had a chance to speak to Zach, he stumbled on the solution to his problem while reading about Windows 11 system requirements. By enabling TPM 2.0 on his board, his PC now restarts properly. He asked us to print the tip for others, which we're obviously happy to do. ■

How to install Windows 11 fresh

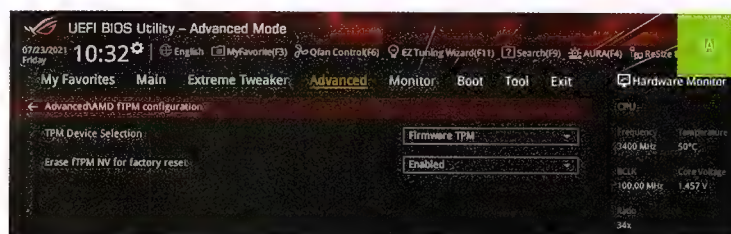
Do a perfect clean install of the latest insider build, with Zak Storey.

YOU'LL NEED

- 8GB USB 3.0 Flash Drive
- Internet Connection.
- Another PC or Laptop

The prodigal son has arrived, Windows 11 is here in all of its insider glory, complete with quirky new taskbar layout, updated start menu, and enough options-baked-into-options to make even the most enthusiastic PC nerd happy. That said, in the world of Windows you often get two camps of people – those who like to perpetually update their machines, never performing a clean reinstall no matter the bugs or issues, and those people opposite to that. The ones who will happily flatten everything at the drop of a hat if it means a cleaner system.

And let's face it, with the myriad of problems that occurred moving from Windows 7 to Windows 8 and 8.1, and then from Windows 8 to Windows 10, the idea of a fresh install is certainly appealing. So, as we're still waiting on Microsoft to release an official ISO or Media Tool Kit for Windows 11, we're going to need to jump through some perfectly safe hoops to get ourselves a squeaky clean install of



the latest OS for you to play around in.

Compatibility check

Now, technically, you can just install Windows 11 from ISO right now without too much of a worry – you don't need to enable Secure Boot, nor do you need to enable TPM 2.0. However, this may change in the coming months after various updates kick in, so the first thing you'll want to do is identify whether your system is compatible or not.

We've covered this in-depth across multiple features and columns at this point, but basically, you're going to need

either an AMD Ryzen 2000 series chip or higher, or an Intel 8000 chip or higher to get this sweet, sweet Windows 11 goodness on your rig.

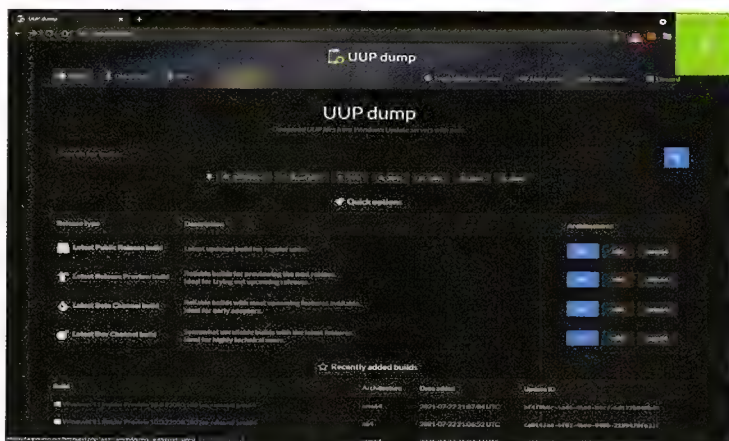
If you can tick both of those boxes above, the first thing you'll want to do on the system upon which you're going to install Windows 11 is head straight into the BIOS. Once there, you need to be looking for two settings, typically found in the advanced area and boot areas of your UEFI BIOS.

Their location will vary depending on the motherboard and processor, but first up you're looking for "fTPM configuration" [Image A]. Once in there, make sure the option for "Firmware TPM" is selected. Then head into the "Boot" section of your BIOS, and look for "Secure Boot". Head into that section, make sure it's enabled, and that the OS Type is selected as "Windows UEFI mode". Then, it's simply a case of hitting F10, "Save All and Exit", and you're good to go.

Finding the ISO

As we mentioned earlier, Microsoft hasn't released an ISO or Media Tool Kit for Windows 11 just yet, so we're going to need to head to a third-party website to download one. In our case, we're going to UUP dump <https://uupdump.net>. It's all legit, and cleared, and is a community-managed repository for Windows updates in general.

Once on the site, you'll notice there's a list of available builds and updates available [Image B]. The one we're looking for is "Latest Dev Channel build". Look to the right of that and you'll have three options. One for x64, one for x86, and one for arm64 (yep they even have the ARM variant). Click the x64 link and it will take you to the latest update. It should say something such as "Cumulative Update for Windows 11 (10.0.22000.100)" or similar. Click

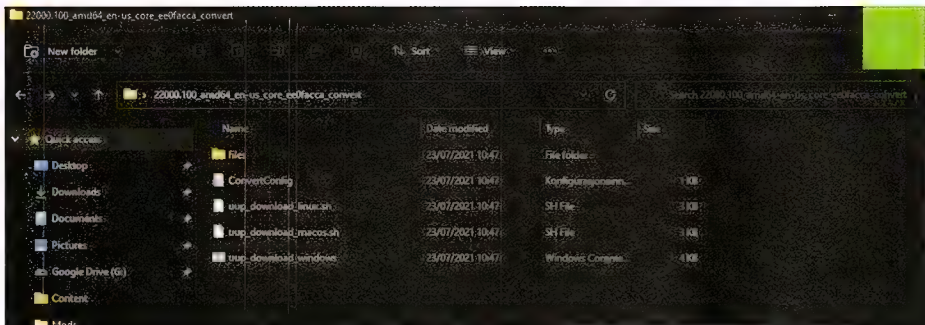


GET YOUR DRIVERS

Before you pull the trigger and start installing Windows 11, we'd recommend grabbing your drivers. There's nothing worse than installing a fresh new OS only to realise your ethernet ports no longer work, or your GPU driver has defaulted to 800x600 on your 34-inch superwide screen.

Head to your motherboard's product page, and grab a few basics, including the Ethernet and Wi-Fi drivers, sound drivers, and chipset (the rest you can get later if you need them). One last thing to note is the graphics driver: currently, only Nvidia has officially released drivers with support for Windows 11. That said, the majority of the operating system is based on Windows 10, so program and driver incompatibility should be fairly minimal.

We've installed everything we'd usually do for a test build with this tutorial, and there haven't been any compatibility issues, apart from a few UI bugs, something we expect with an insider dev build.



the blue hyperlink and it takes you to the next page. Make sure you choose the right language for you, and then hit “Next”.

At this point, you’ll be able to select which version you want to test out. You can choose between Windows Home, Home N, Pro, Pro N, and Windows Team, and although you can opt to download all of them, we recommend that you only pick one. We selected Windows Pro, as that’s the license we have tied to our Microsoft Account.

Create the ISO

On the next page, make sure that the download method is selected as “Download and convert to ISO”, and that under “Conversion options” the checkbox for “Include updates (Windows converter only)” is selected as well. Then, hit the big blue “Create download package” button. You’ll get a small zipped folder labeled with the version number, plus the architecture you’re using (amd64 in our case). Extract that to your desktop.

Open the folder and inside you should find four separate files and a folder called “files”. There should also be three additional “uup_download_X” files in there, one with a linux.sh suffix, one with a macos.sh suffix, and lastly one with a windows suffix. Double click the “uup_download_windows” suffix, Windows might tell you it’s a

dangerous file to run, hit “more info” then “Run anyway” [Image C].

A command prompt will open up, asking for admin permission, allow it, and it starts downloading all of the required ISO files for you directly from Microsoft’s servers. Leave it to complete, it can take a while depending on your internet speeds, and at certain moments may look like it’s hanging (it’s not, just wait it out). Once that’s done, it’ll place an ISO file in the folder.

Creating a bootable USB Stick

Now we need to make a bootable USB stick. This is a workaround, as we can’t mount the ISO directly to the USB drive. Most ISO mounting software automatically formats the drive to NTFS, while we need it to be FAT32 to boot from (Secure Boot doesn’t allow booting from an NTFS drive). The problem is, some of the ISO files are over 4GB, meaning they can’t be stored on that FAT32 partition. To get around this, we’re going to have to format our USB stick in a particular way.

Plug your USB drive into your machine, then go to the start menu and type “partitions”, and open up “Create and format hard disk partitions”. Find your USB stick and delete any partitions that are currently on the stick (this will delete all the data on it, so back it up first).

Once complete, right-click the unallocated space and select “New simple volume”. This is going to be our FAT32 boot partition, so you’ll want to make it 1000MB. Set the file system to FAT32, name it something memorable (in our case BOOT), [Image D] then perform a quick format. Do the same with the remaining space, but make sure it’s NTFS and again label it something different “DATA” as an example.

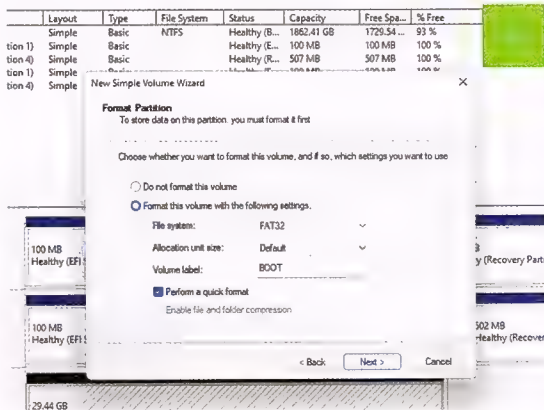
Mounting the ISO

Go back to your Windows 11 ISO download folder, and locate the ISO file it should be labeled as “22000.100.210719-2150.CO_RELEASE_SVC_PROD2_CLIENTCORE_OEMRET_X64FRE_EN-US” or similar. Right-click the file and select “Mount”, this will create a virtual CD drive and mount the ISO file to it, giving you access to everything inside. Select and copy everything there, except the “sources” folder, and paste it into the “BOOT” FAT32 part of your USB stick we created earlier.

After that’s done, in the same FAT32 partition of your USB drive, create a folder called “sources”. Now go back to your mounted ISO folder, into the “sources” folder there, and copy the boot.wim file, and place it in your new “sources” folder on your BOOT/FAT32 partition.

Finally, go back to your mounted ISO, copy everything, as well as everything you copied before, and paste it all in your DATA/NTFS partition on your USB stick. And there you go, one complete bootable USB stick with a Windows 11 ISO on board ready for a fresh install.

Now it’s simply a case of plugging the USB stick into your machine, booting off it, following the usual install procedure and you’ll have a slick Windows 11 desktop. ■



LEFT ALIGN TASKBAR

Not feeling that centralised taskbar? Us neither. Sure, it looks all Linuxy and MacOSy, but let’s be realistic, we’ve been using Windows with a start menu on the bottom left for well over 30 years at this point, so why the heck change it?

There were a few early workarounds to solve it, including registry hacks. Third-party apps, such as Classic Start and Start10 from Stardock, popped up, but there’s an integrated way that’s a lot less hassle, and cheaper than Stardock.

Right-click the taskbar, select “Taskbar settings”, open the “Taskbar” tab, then click the “Taskbar behaviors” tab, and choose the “Taskbar alignment” option. Here you can move the taskbar to the middle or to the left, depending on your preference. Thank you for listening Microsoft.



APPLE MAC

Play live with your Mac

Burst out of the bedroom and take your Mac on stage, with Carrie Marshall.

IT WILL TAKE
20 minutes

YOU WILL LEARN
How to loop in Logic
and export to Ableton

YOU'LL NEED
Logic Pro X

Creating and recording music on your Mac is a popular and fun way to use your machine, but what about performing? Whether you're a rock band or a bedroom techno overlord your Mac can be a really powerful tool when you want to play live.

In this tutorial, we'll look at two big-name apps, Apple's Logic Pro and Ableton Live. They aren't the only options – most loop-based music apps can happily play live too – but they're the most popular choices. Ableton is a familiar sight

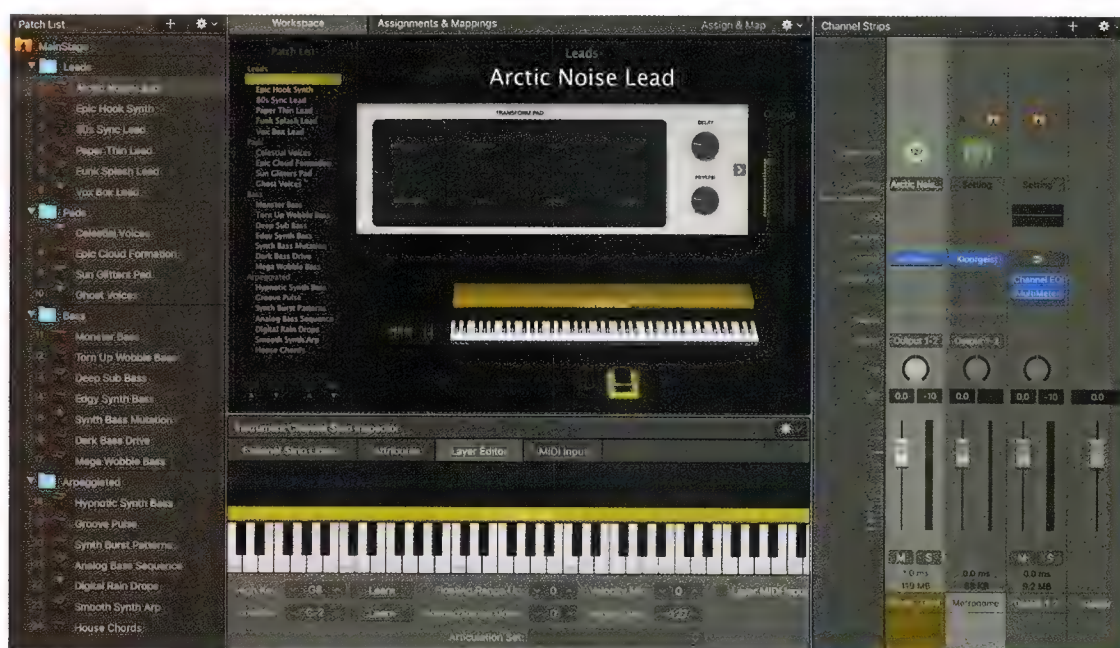
on big stages; unlike Logic it was created specifically for live performance. But with the arrival of Live Loops, Logic has now caught up.

Taking it to the stage

Apple has another app for live performance called MainStage, which enables you to bring all your Logic instruments and tracks on stage, but our experiences of it haven't been brilliant: for us it did the one dreaded thing you don't want your live music app to do,

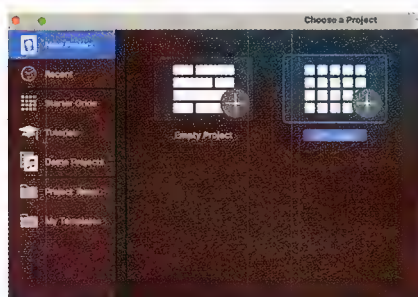
and that's crash mid-song.

When you're using music apps on stage there are typically two ways to do it. There's the electronic way, where everything is either happening in your Mac or controlled by it (for example, by playing sampled instruments and controlling MIDI instruments), and there's the more traditional way where you have live instruments playing to a backing track or tracks. With both versions you'll need an audio interface to connect your Mac to the mixing desk or PA.



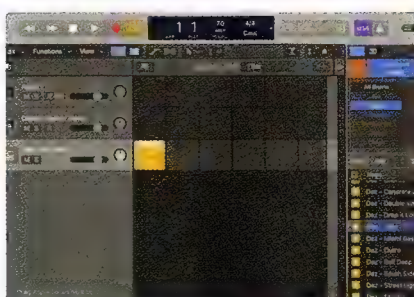
Apple offers the MainStage app for backing tracks and taking your Logic sounds on the road, but we've encountered problems with its stability.

HOW TO Loop in Logic Pro and export to Ableton



01 Prepare your project

You can access Live Loops from within an existing Logic Pro X project or you can start a new one via the Choose A Project window. There's also a good Live Loops tutorial in the Tutorials section here. Let's start a new Live Loops project.



02 Add a loop

The grid in the centre is where loops live, organised by instrument just as tracks are in a normal Logic Project. This time, though, they're also organised by columns. To add a loop, drag it from the Loop Browser to the appropriate square.



03 Add some variety

Each column can contain multiple loops, so you might have the first for your intro, the second for your verse, and so on. You can adjust how loops behave – so if you want to reverse a drum loop, for example, control-click it and choose Reverse.



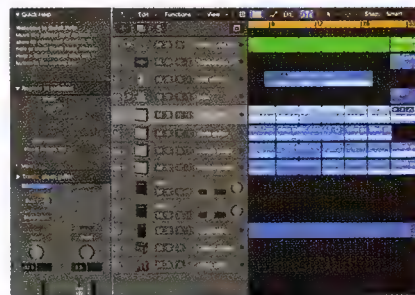
04 Record a new loop

You can import existing audio files to the Live Loops view or record your own playing. We're playing some live bass guitar here: just add and record-enable a new track, select the box you want to record into and click Record.



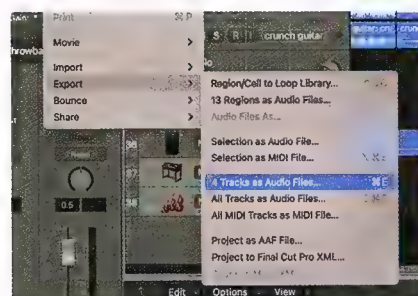
05 Add the live bits

In a live performance, you can now trigger individual loops by clicking them or an entire column by clicking the footer. You can also set up a new track such as a vocal mic, enabling you to sing over the top of whatever loops you're playing.



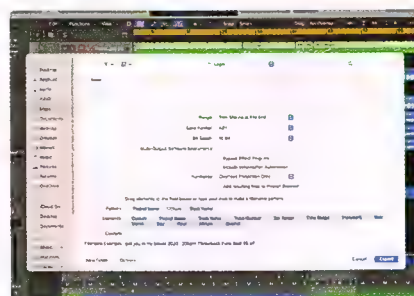
06 Bring the band

What if you want to export a backing track to play along to? No problem. Open your project, make sure that the yellow Cycle bar at the top runs from the start to the end and then select the track(s) you want to export.



07 Sort out stems

To export tracks as stems (individual audio files), select File > Export > X Tracks As Audio Files (or as MIDI if exporting for use in a MIDI app). You can also extract individual regions to add them to the loop library for future loopiness.



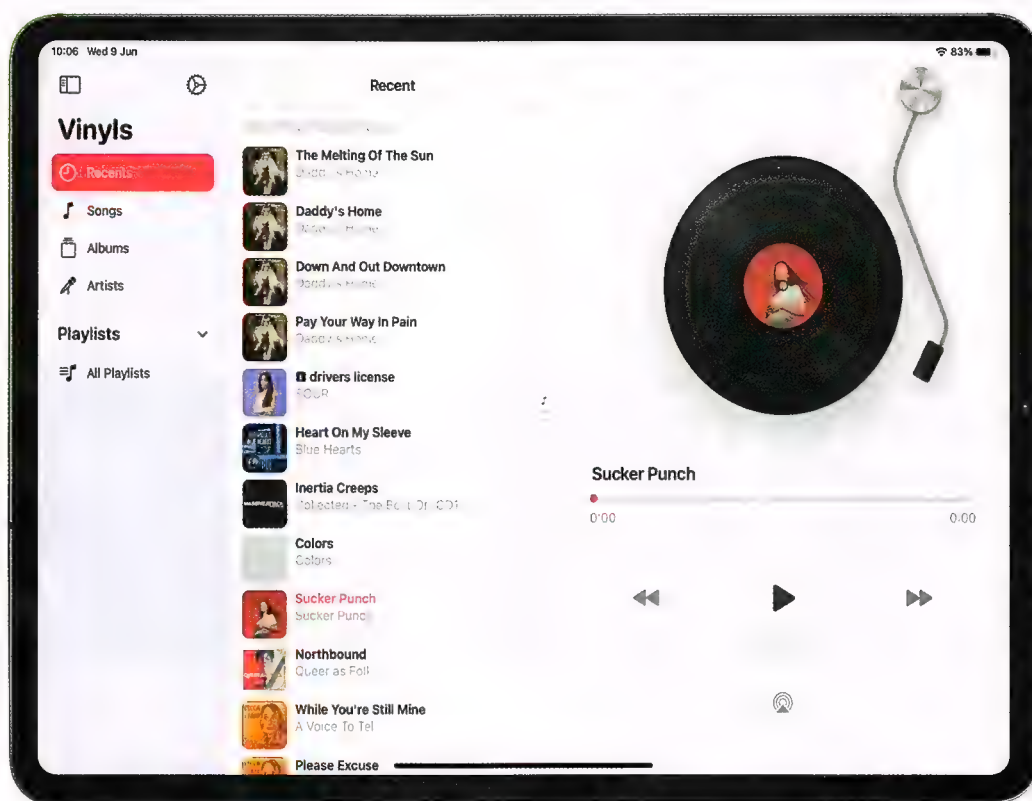
08 Label everything

This looks a bit complex but it's quite simple: it enables you to set how Logic names each exported track – for example, here we've got the project name, the BPM (which we've entered manually), and the name of the track.



09 Import the audio

Once you've exported your stems, you can drag and drop them into a live app such as Ableton Live, shown here, and organise them into songs. You can also add effects such as compression to ensure consistency across your set. ■



APPLE iOS

Give your music a spin

Get back into a retro turntable vibe with the Vinyls app.

IT WILL TAKE
10 minutes

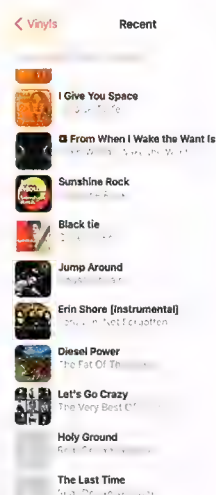
YOU WILL LEARN
How to give Apple Music a retro makeover

YOU'LL NEED
Apple Music, Vinyls app (\$4.99, macOS 11 or later/iPadOS 14.1 or later)

You can turn on Display Vibrant Background in the app settings to display a blurred image of the cover behind the current song being played.

Apple Music is a wonderful service. It's the ultimate jukebox, the greatest ever music collection, an always-on, always-updated compendium of the most exciting artists of all time.

But sometimes we can't help feeling that it's maybe a little too modern, a little too shiny, a little too digital. Remember the feeling when you pressed play on a tape deck or dropped the needle onto a vinyl record?



For some Apple Music users, the answer is no: physical music formats are historical artefacts, just like floppy disks, monocles and unicycles. But there's something magical about music on vinyl, and Vinyls attempts to transfer that magic to the world of digital music. It's a great interface for your Apple Music albums and playlists.

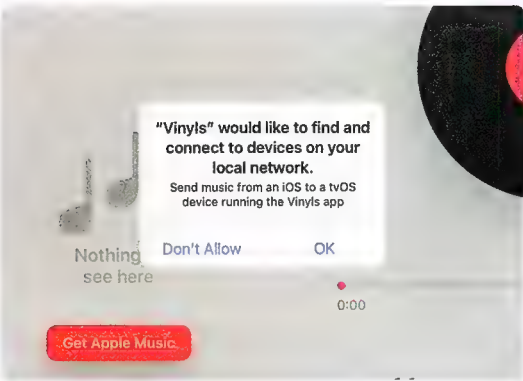
AR spin

Vinyls looks like a record player emulator, and it is: it takes the Apple Music interface and adds a spinning record, complete with tone arm. But it makes good use of hardware too. You can AirPlay to your wireless speakers, or run the app on your Apple TV, iPhone, iPad or Mac (where it works with the Touch Bar), and on mobile there's a fun AR mode that enables you spin a disc on the sofa. The app settings give you lots of control over how it looks and over gesture and touch controls, and there are good accessibility options too.

CARRIE MARSHALL

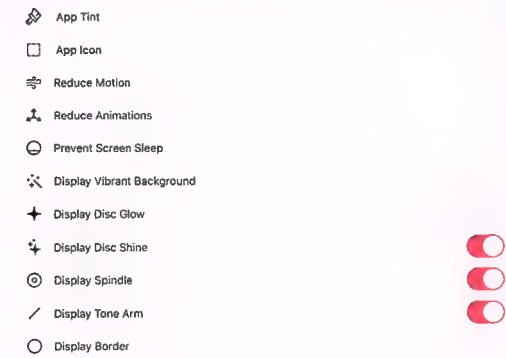
Vinyls looks like a record player emulator, and it is: it takes the Apple Music interface and adds a spinning record, complete with tone arm. But it makes good use of hardware too.

HOW TO Use Vinyls with your music



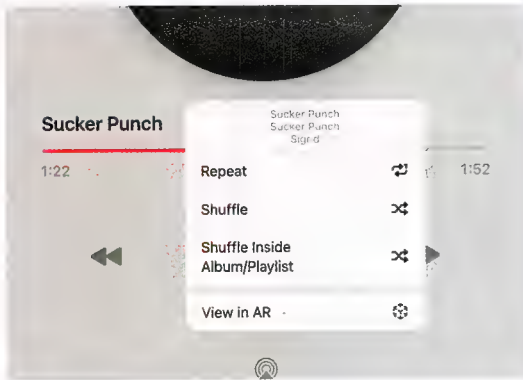
01 Give permission

Vinyls needs your permission for two things: to connect to other devices such as your Apple TV, and to connect to your Music app and Apple Music account. Vinyls doesn't currently support other music streaming services.



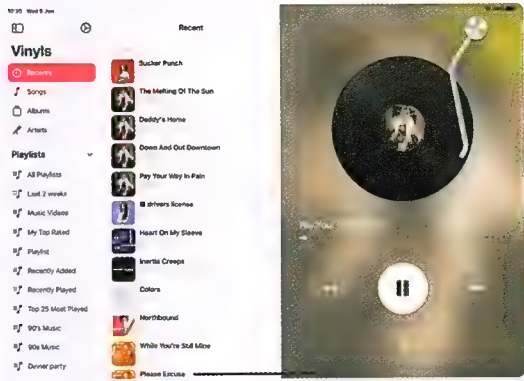
03 Pick your player

There are lots of options in the Settings section, including some useful ones for people who need to reduce motion. The first section of Settings is all about the visuals: you can choose what bits you'd like to see on screen.



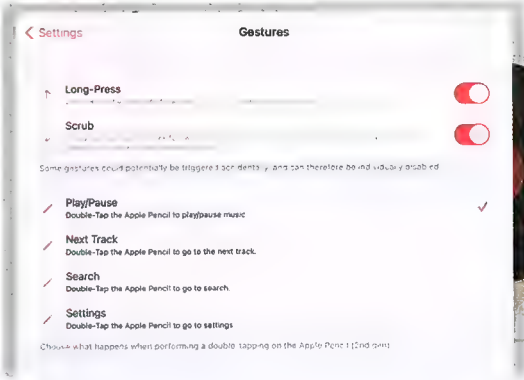
05 Bring up extras

In addition to AirPlay (to stream to smart TVs, speakers and Apple TV), you can also long-press on the record to bring up this menu. This gives you Repeat and two Shuffle options, and it also enables you to activate AR mode.



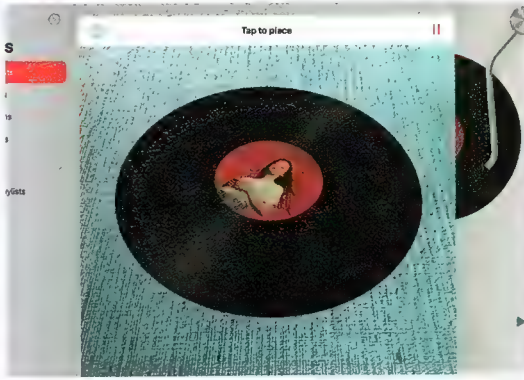
02 Pick a song

Vinyls looks similar to the Music app – the sidebar shows playlists, artists and albums; the currently selected playlist is in a second panel, then the selected song is in the main window. You can swipe the playlist sidebar in and out.



04 Focus on fingers

Scroll down further to see the options for gestures, which you can use to control the app. There are two kinds of gestures here: presses/swipes with your finger, and taps from the second-generation Apple Pencil.



06 Put the record anywhere

AR mode is fun. Point your camera at something, tap where you want your record to go and it starts spinning in place. The virtual record player components aren't displayed; just a vinyl record spinning.

JARGON BUSTER
Vinyls are vinyl records, which is what we oldies used to call our magical spinning discs of music in the pre-iPod, pre-streaming era.



GENIUS TIP!
Vinyls' Settings > Playful Options enable you to add the sound of dust and scratches to your music for extra retro realism

Stress-test your CPU

While Shashank Sharma isn't fond of stress-testing the weighing scale, he's fine with tools like S-TUI, which help him monitor CPU performance.

Over the past few years, we've introduced a blend of powerful and robust as well as nifty and nimble command-utilities that help you perform a variety of tasks. Everything from everyday text editing, connecting with remote machines, performing backups and other administration tasks can be done from the terminal.

A key matrix for determining the vitality of a Linux distro, or the hardware that it runs on, is system performance. Depending on your purpose, you can choose from a variety of dedicated tools to monitor the different components such as CPU frequency, temperature and memory utilisation. But if you favour the CLI, like us, you'll rather enjoy working with S-TUI.

With S-TUI, which is an acronym for Stress-Terminal UI, you can simultaneously monitor CPU temperature, frequency, power and utilisation. The utility presents all the information graphically and can even be used to export the data into CSV files. Better still, you can configure S-TUI to automatically launch scripts when the values of any of the components being monitored breaches the defined threshold values. When coupled with stress, another command-line utility, S-TUI can also be used to stress-test your system.

Don't stress over installation

Although S-TUI isn't available in the software repositories of most popular desktop distributions,

QUICK TIP

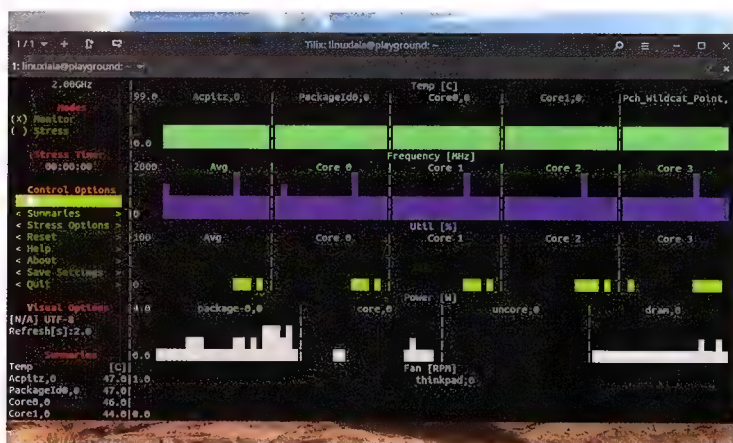
The stress utility performs a loop that calculates the square root of a random number in order to stress the CPU. You can customise the stress options by navigating to the Stress Options screen from the S-TUI sidebar. The graphical interface enables you to define all the major settings such as the worker count for the `sqrt()`, `sync()`, `malloc()` functions, as well as choose whether to dirty the memory.

installing the tool is fairly straightforward, and the project's GitHub page describes various installation techniques. If your Linux distribution is already configured to use `pip`, you can install S-TUI with the `sudo pip install s-tui` command.

For other installation methodologies, such as installing it from Git, you'll have to ensure all the dependencies are installed. These include tools such as `urwid` and `psutil`. Although it isn't a dependency, if you decide to use S-TUI to also stress-test your CPU, you should also install `stress` or `stress-ng`. Thankfully, these are offered in the software repositories of almost all desktop distributions.

Unlike many other command-line utilities, S-TUI requires no configuration and you can begin using it immediately after installation. Run the `s-tui` command to launch the utility.

At the top of the sidebar on the left are the details about your CPU. Our Lenovo test machine was correctly identified as running an Intel Core i3-5005U CPU @ 2.00GHz processor. This is because S-TUI utilises various other native tools and utilities to gather the relevant information. For instance, the same information and far more details can be



Some sensors, such as Power, are only available when you run S-TUI as `sudo`, and not as a regular user.

MAKING USE OF THRESHOLD SCRIPTS

In addition to the `s-tui.conf` file, the `~/config/s-tui` directory also contain a directory called `hooks-d`. You can place custom scripts you wish to execute when a certain threshold, such as CPU temperature or frequency is exceeded, within this directory. The name of the script must be `<name>source.sh`, where `<name>` is the name of the supported source. While you can use S-TUI to track various sources, for now it only supports running scripts based on CPU temperature threshold setting.

The default threshold value for the CPU temperature is 80. To change this value, you

must invoke S-TUI with the `s-tui --t_thresh <value>` command.

You can then save the new threshold value into the `~/config/s-tui/s-tui.conf` file by saving the settings from within S-TUI itself.

If you make any changes to the settings from within the S-TUI interface, and wish to save them for future use, you'll need to navigate to the Save Settings option on the sidebar and then press Enter. Depending on how you installed S-TUI, you may have to amend the file permissions on the `s-tui.conf` file for it to be writeable, otherwise the tool will exit with a curt 'Permission Denied' error.

When you now open the `s-tui.conf` file in a text editor, you'll find a new entry showing the newly defined temperature threshold value:

```
[GraphControl]
refresh = 2.0
utf8 = True
tthresh = 70
```

While the stress testing feature is of little use to home Linux users, there's no denying the benefit of graphical representation of the collected data for administrators and programmers.

ascertained from running the `cat /proc/cpuinfo` command.

When you first launch S-TUI, it displays all four parameters – Frequency, Utilization, Temperature and Power – and refreshes the data for each every second. You can change the refresh rate by changing the value of `Refresh[s]:1.0` on the sidebar.

Depending on your terminal application, and the colour scheme, you may not be able to clearly see the different elements on the S-TUI interface. Should this happen, exit S-TUI, then switch to a basic White-on-Black colour scheme on your terminal emulator, and run S-TUI again. You should now be able to see all the different colours used by S-TUI to display all the collected information, and you can edit your terminal profile accordingly.

You can use the up and down arrow keys to navigate the sidebar, but S-TUI also supports the use of H and J to scroll, much like you would in Vim.

Added stress

By default, S-TUI is configured to only monitor your system. This is evident from the (X) next to Monitor on the sidebar. If you installed the stress utility as well, you can enable the stress feature by navigating to the Stress entry on the sidebar and pressing the spacebar. You'll notice the empty brackets would be replaced with (X) now. You can similarly enable or disable monitoring of the different components. When you disable a component, the corresponding graph will

You must refer to the man page and documentation on the stress utility to understand the different supported functions.

Although S-TUI isn't available in the software repositories of most popular desktop distributions, installing the tool is fairly straightforward, and the project's GitHub page describes various installation techniques.

automatically disappear from the interface.

Unlike most other command-line utilities, S-TUI can also be controlled with the mouse. You can left-click on an entry/option in the sidebar to select it. You must still hit Escape to return to the main screen and use the arrow keys to scroll through the sidebar as the scroll-wheel on your mouse doesn't work with S-TUI. To disable the mouse, you must invoke S-TUI with the `s-tui -nm` command.

You can also switch to a different temperature sensor from within S-TUI itself, if you believe the graph is inaccurate. Navigate to the 'Temp Sensors >' entry on the sidebar, and press Enter. This opens the Available Temperature Sensors dialog, and you can then select one from the list. As before, after navigating to an entry in the list, press Spacebar to select it. Remember to select Apply for the changes to take effect.

You must hit Escape to return back to the main screen of the application, such as from the About > Help or Temp Sensors section.

While the graphical interface for S-TUI also has a Help section in the sidebar, it provides little more than a quick introduction. For a complete list of all the supported command options, run the `s-tui -help` command.

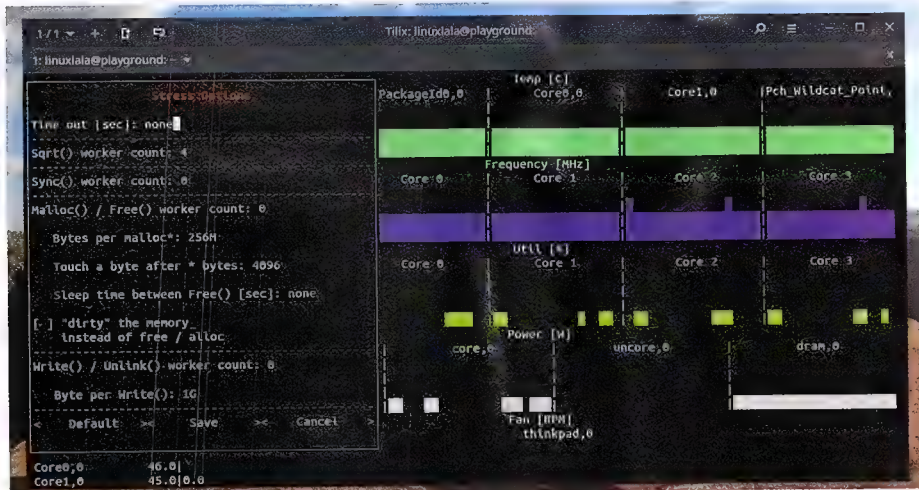
The collected data is lost as soon as you exit S-TUI, because the tool doesn't save it by default. If you want all the collected information to be automatically saved to a CSV file when you exit S-TUI, you must invoke the utility with the `s-tui -c` command. The collected data will be stored in the users' home directory. You can then view the `s-tui_log_<TIME>.csv` file in your preferred text editor. You can also provide a custom name for the CSV log file with the `s-tui -c <path_to_CSV_file>` command.

Another useful command option is `-j`, which can be used to print on the screen the current status of the machine in JSON format. The output generated by the `s-tui -j` command is a record of the current status of the machine, and not a running log:

```
$ s-tui -j
{
  "Frequency": {
    "Avg": "1282.1",
    "Core 0": "1630.6",
    "Core 1": "1295.6",
    "Core 2": "1175.6",
    "Core 3": "1026.4"
  },
  "Temp": {
    "Acpi_tz0": "48.0",
    "PackageId0_0": "49.0",
    "Core0_0": "47.0",
    "Core1_0": "47.0",
    "Pch_Wildcat_Point0": "40.5"
  },
}
```

S-TUI supports a number of different temperature sensors and you can choose a different one by navigating to the Temp Sensors screen. This is only needed if the default configuration fails to accurately graph the CPU temperature on your machine.

All the basic settings such as the refresh rate (in seconds), and which components to graph by default are stored in `~/config/s-tui/s-tui.conf`. Unfortunately, you must set the Stress options and the temperature sensors every time you run S-TUI as the tool doesn't permit saving these settings in the configuration file. ■



RASPBERRY PI

Building robots in Scratch with GPIO

Take your first motorised step with Les Pounder as he shows you how to use Scratch to build and control a simple robot.

Robots are very cool and the Raspberry Pi GPIO is the ideal way to control them. We can do this using Scratch. In this tutorial we shall learn the basics of working with the GPIO in Scratch by first controlling an LED before applying the same principle to control the motors of a robot. If you're unsure as to how to build a robot, we have a short guide in the boxout which may just help. So let's build a robot!

Scratch 3 should come pre-installed on your Raspberry Pi OS image, but just in case it's missing it can be installed from the main menu, under Preferences > Recommended Software. Scratch 3 is found in the Programming category; place a tick in the box and click Apply to install. Once installed, Scratch 3 can be found in the main menu under Programming.

Open Scratch 3 (on first start

Scratch may take a little while to open). We're going to assume that you have an understanding of how to code with Scratch. Before we write any new code we need to click the blue folder icon in the bottom left of the screen to load the Extensions menu. From there select Raspberry Pi GPIO and a palette of new blocks is added to our code.

Our first project will get us familiar with the basics of using the GPIO with Scratch. Our focus moves to the Raspberry Pi itself and our electronics. In a breadboard, insert the LED and make a note of which leg is shorter. In the shorter leg side, connect one leg of the resistor. The other leg can be placed in another row of the breadboard. Using two jumper jerky wires, connect the leg of the resistor to any GND pin on the Pi. Connect the other leg of the LED to GPIO17.

Please see the high-resolution

YOU'LL NEED THIS

- Any model of Raspberry Pi (best with 3, 4, 400)
- The latest Raspberry Pi OS
- A long HDMI cable
- A robot chassis (see boxout, facing page)
- 1 x LED
- 1 x 220 Ohm resistor (RED RED BROWN GOLD)
- 2 x Female to Male jumper jerky
- 4 x Female to Female jumper jerky
- Breadboard
- 2 x DC motors with solder wires attached
- A motor driver board (we used Cytron's Maker Drive)
- 4 x AA batteries and battery holder
- Get the code at github.com/lesp/LXF279-Scratch-Robot/archive/refs/heads/main.zip

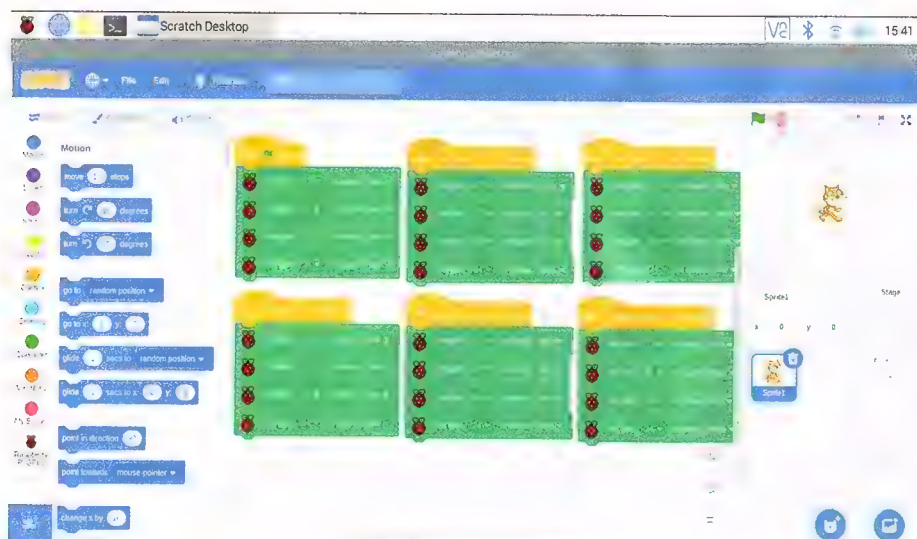
Our first project will get us familiar with the basics of using the GPIO with Scratch. Our focus moves to the Raspberry Pi itself and our electronics.

The code to control our robot is relatively simple. We need only a few blocks – many of which are duplicated – to digitally control the motors.

diagram in the download for this issue.

Moving back to Scratch and we start the code by dragging **When Green Flag is Clicked** from Events into the coding area. Next we drag **repeat 10** from Control and connect that to the previous block. The remaining blocks will be inserted inside the **repeat 10** loop. From Raspberry Pi GPIO drag two **Set GPIO 0 to output high** and place them in the loop. Change the first to read **Set GPIO 17 to output high** and the second to **Set GPIO 17 to output low**. These two blocks will turn the LED connected to GPIO 17 on and off 10 times. But to see the change we need to place a **Wait 1 Second** from control in between these blocks, and another after turning the LED off. When you're ready, click the Green Flag above the stage to run the code. The LED should blink 10 times, on for one second, off for another second.

This test has confirmed that our GPIO is working with Scratch 3, and that we understand the principles of turning a GPIO pin on and off. This is digital IO control and is the most basic electronic concept.



Controlling motors

Robotics is a great way to learn coding. However, the one problem is that the Raspberry Pi's GPIO can't directly control a motor because it requires more power than a GPIO pin can safely provide. We instead control a motor driver board that sends power from batteries to the motors. We chose Cytron's Maker Drive motor controller because it's clearly labelled and has test buttons for checking motors without any code.

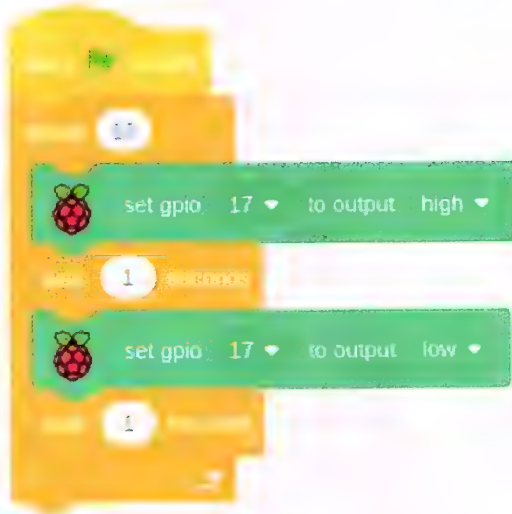
Connect the GPIO of the Raspberry Pi to the M inputs using the female to female wires, as follows:

```
GPIO 17 > M1A
GPIO 27 > M1B
GPIO 23 > M2A
GPIO 24 > M2B
```

Now connect the motors to the screw terminals for M1A/B and M2A/B. It doesn't matter which wire goes in which terminal. Connect the AA battery holder into VB+ (Red, + wire) and VB- (Black, - wire), then insert the four batteries. Press the four buttons on the Maker Drive board to test the motors work on battery power.

Delete the code from the previous project. Our first task is to set up the GPIO pins used to control the motors. When the code starts we need these motors to be off, otherwise we're chasing a robot around the desk!

Drag **When Green flag is clicked** from Events into the coding area. Next drag four **set GPIO 0 to output high** from Raspberry Pi GPIO and connect them all



This is all the code that we need to understand how to turn an LED on and then off. Using this principle we can control a motor, duplicate it, control two motors and then build a simple robot.

QUICK TIP

Double-clicking on a block will activate it. This can be handy for quickly testing functionality and it can be annoying when done accidentally. Pressing Stop should stop all the blocks from running.

under the Green flag block.

Change the value of 0 in each block to 17, 27, 23 and 24 and set them all to low. This sets all of the GPIO pins for the motors to off.

Next we create a sequence of code that will stop the robot from running away by turning the motors off. Go to Events and drag **When Space key pressed** into the coding area. To stop the motors we turn them all off, and we can reuse the four blocks from the **When Green flag** setup script. Right-click those bricks and select Duplicate. This copies all of the blocks in the sequence, but we can throw away the green flag block. Connect these blocks to the **When Space key pressed** block.

To make the robot move forward we take another **When Space key is pressed** from Events, changing the **Space** to **Up Arrow**, and then duplicate the four blocks that

control our GPIO. To move forward, the robot has two wheels: one wheel will go clockwise, the other anti-clockwise. To do this we set GPIO 17 and 24 high, and 27, 23 low. Give the code a test. Press the up arrow to move the motors forward, then press Space to stop. Did the motors move as expected? If not, unscrew the terminal on the incorrect motor and swap the wires over, for example swap M1A for M1B, and M1B for M1A.

To make the robot move backwards we need to duplicate the previous blocks, and change the **Up Arrow** to **Down Arrow** and then set GPIO 17 and 24 low, 27 and 23 high. Give it a test – does the robot behave as you expected? If not, switch the motor screw terminals until you find the correct movement.

To move left, duplicate the blocks used for backwards movement. Change **Up Arrow** to **Left Arrow** and then alter GPIO 17 and 24 high, 27 and 23 low. Give it a test – does the robot behave as you expected? If not, switch the motor screw terminals until you find the correct movement.

To move right, duplicate the blocks used for left movement. Change **Left Arrow** to **Right Arrow** and then alter GPIO 27 and 23 high, 17 and 24 low. Does the robot behave as you expected? If not, switch the motor screw terminals until you find the correct movement. Save the code (File > Save) and take your robot for a drive and hopefully not off the table! ■



Use these Scratch instructions to move your robot. Hopefully it all works as expected. But beware: this is how the robot uprising starts!

ROBOT KITS

We have the bare electronics for the robot, but lack a chassis. Fear not! We can go down two routes: a kit or a DIY option. By far the easiest way is to use a kit. These kits can be found on eBay and Amazon for around \$20 and they provide the motors, wheels, battery pack and laser-cut acrylic chassis along with all the fixings. These kits are a bit like Ikea furniture, and without too much work we can have a chassis ready for our Raspberry Pi. Look for a kit that comes with pre-soldered motors, it saves a lot of time. But if you can solder, and have the kit, no problem.

The DIY option is more adventurous. If you have access to a laser cutter or 3D printer then you can customise your robot chassis and build the ultimate bot! But what if you don't? A hot glue gun, some strong cardboard, a castor, your motors and wheels are enough for a simple proof-of-concept robot. If you have access to LEGO, especially Technic or Mindstorms, then these can be used to fashion a chassis. There are even adapters for using micro gear metal motors with Technic wheels. These can be bought cheaply from Pimoroni, and there are LEGO-compatible cases that can be built into a project.

Micro:bit Part 3: The (almost) infinite world of sensors

Sensors are the link between the digital and physical worlds. In the final part of this series, Darren Yates shows how the list of Micro:bit's on-board sensors can light up your imagination.

We all love the PC for the computing power it delivers, but these days, there's equally as much fun to be had with the booming world of microcontrollers and single-board computers – and the latest micro:bit V2 Go is no exception. Over the last couple of months, we've shown how you can code it not only with any PC, but also your Android tablet and smartphone. But what makes the micro:bit board a great learning tool is the list of built-in sensors that allow the board to interact with the physical world. This month, we look at how you can have fun with this combination of sensors and compact, low-cost micro-computing, plus how it's bringing STEM to life in the classroom and how sensors are helping develop new solutions in university research.

The real world is (almost) infinite

One of the first PC peripherals that took off in the early-90s was the sound card. We don't give it a thought today, but those early 8-bit sound cards gave us music (albeit cassette-quality), despite only capturing the real world with

just 256 distinct levels. But the arrival of 16-bit stereo sound cards with their 65,536 levels revolutionised PC audio, giving us a new experience of audio quality that still drives PC games and phones today.

The key component in every sound card that's also required by many sensors is the analog-to-digital converter (ADC) – this device converts the almost limitless changes in analog 'real world' electrical voltage into discrete digital numbers computers understand. Many sensors today include not just the sensor that reads the physical parameter you want measured, but also an ADC to convert this into an easy-to-use digital output that can be connected to microcontrollers and computers.

In fact, sensors, in general, have now reached that happy medium where they deliver sufficient resolution to capture enough of the real world, but at low enough cost that you'll find all sorts of sensors on a \$30 education computer. So aside from a microphone and speaker for capturing and outputting audio, the micro:bit V2 Go has a touch

sensor, a 5x5 LED grid to display light and data, a light sensor for detecting light, a magnetometer to detect metal, electric currents or the earth's magnetic field. There's also an accelerometer to measure movement, plus a thermometer to measure temperature.

Size counts

However, what you might not realise is just how small many sensors are now. We've included an image of the Bosch BME280, which measures temperature, relative humidity, and barometric pressure. If you want to make your own weather station, one of these BME280 boards you'll find on Ebay for around \$5 is a great place to start. However, the actual sensor on this board is the upside-down frying pan-shaped silver blob that measures no more than about 3x3mm. The accelerometer sensor on the micro:bit (and in your phone) is no bigger. This small size enables sensors to find their way into everything from phones to drones and do their thing.

The APC Music Maker

So for our last project this series, we're having a bit of fun and

Below left: Today's discrete PC sound cards use analog-to-digital converter tech to capture sound.

Below right: The Flir E6 uses a special imaging sensor to capture temperature at a distance.



turning the micro:bit's sensors into a 'music maker', a device able to create haunting melodies just by how you hold your micro:bit board – and by 'haunting', we mean you'll likely never get the sound out of your head. You can grab the source code at <https://makecode.microbit.org/91550-42114-17787-41852>, download it to your micro:bit V2 board and away it goes. We've also annotated the source code to help you understand how it works. It uses the Y-axis output of the accelerometer sensor to set the speaker output level, while the X-axis sets the note played (think the white keys on a piano from C to an octave above C) through the built-in speaker. Face the board vertically with the speaker towards you, tilt it forward to drop the audio volume; rotate it left and right to change notes. (Note to parents: don't worry, it's not too loud).

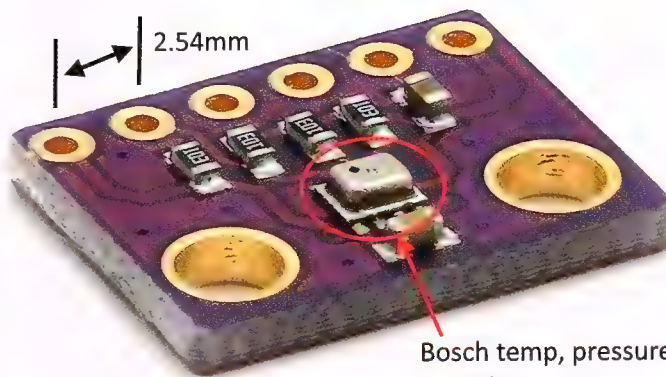
Sensors driving university research

The PC provides vast amounts of processing power, only a fraction of which fits into boards like micro:bit, but that's more than enough to gather data that can be world-changing. Yet, although sensors are fun, they also play a central role in research, developing solutions to the world's most significant issues. For example, the field of 'image spectroscopy' – special image sensors that measure a much broader spectral range than we can see – features in agriculture to detect and improve grain quality in harsh climates, while thermal imaging cameras provide unique views of anything you can point a camera at. Remote temperature sensors record the effects of climate change, then there are the biosensors being developed to detect COVID-19 anti-bodies.

Using sensors in the classroom

Still, some of the most important research happens in the classroom, particularly when it inspires the next generation to think 'STEM' and sensors play a big part in that. The micro:bit website has a number of resources that look at the concept of 'energy' (<https://microbit.org/lessons/energy-awareness/>) and how it can be measured using the micro:bit's sensors. For example, simple ideas of using the

The BME280 temp/humidity/pressure sensor is tiny, barely 3 x 3mm in size.



Bosch temp, pressure humidity sensor

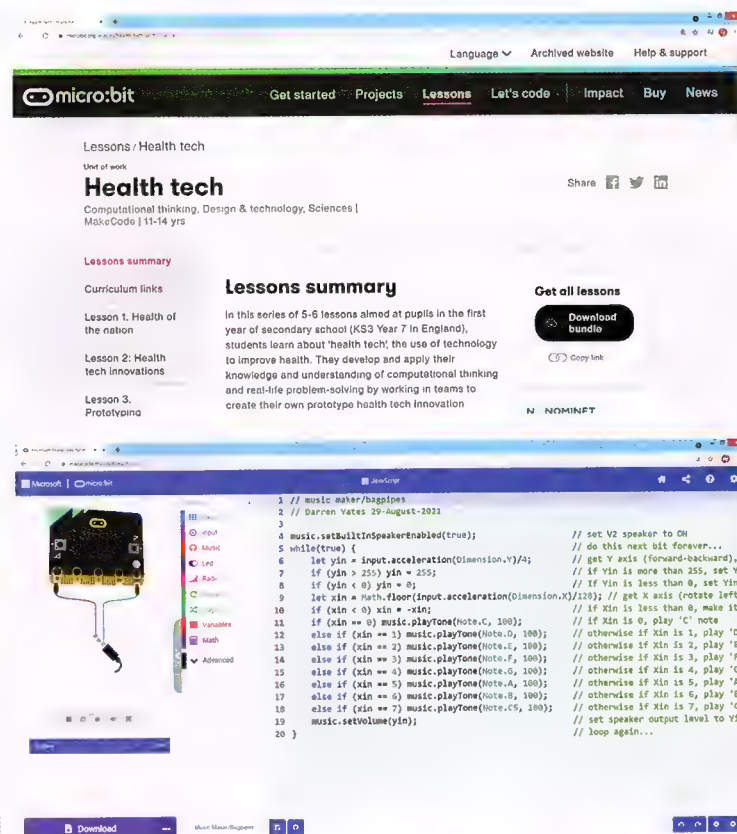
micro:bit's light sensor to detect light levels as well as timing how long lights are left on in a room. Data recorded can be later analysed to understand more about energy usage.

There's another lesson plan around health technology (<https://microbit.org/lessons/health-tech-unit-of-work/>) including getting students to develop ideas for innovating new healthcare devices (based around the example of the accelerometer sensor and making a step counter).

The built-in magnetometer also allows you to turn the micro:bit into a basic compass, even a crude metal detector. Start to combine sensors in your code and you're only limited by your imagination.

Life-long learning

That's where we'll leave this short series, but it's not where it ends. Learning about sensors and coding is something all kids should be encouraged to at least try, if only to introduce them to the broader world of STEM. If nothing else, the last 18 months have shone the light on how important Science, Technology, Engineering and Mathematics have become to a rapidly-changing world. Devices like micro:bit make that introduction fun and practical, hopefully inspiring some – both young and old – to take the plunge, have a go and learn something new. And if you're reading APC, you have few excuses not to. ■



Top: Looking for free micro:bit learning resources? Head to microbit.org for more.
Right: Build your own musical instrument with our 'Music Maker' code – see text for details.

MACHINE OF THE MONTH

Original Macintosh (1984)

Emulating the legendary icon, with John Knight.

The original Macintosh (or “Mac” for short) is an iconic machine that brought home desktops to the masses and established a line of computers that is still going today. Its compact form, cool styling, and elegant graphical interface immediately won the hearts of creative people worldwide, and would influence many desktops that followed.

However, it's now very difficult to find original Macs in good working order, and it's even harder finding working Macintosh floppy disks.

This leaves emulation as the only way most people can now experience these machines, which can be tricky in itself. So, after a brief history tour, let us guide you through the process of emulating the Macintosh.

Development and release

Launching in January 1984, the Macintosh was the first successful home computer to use a graphical desktop, and also to use the 16-bit Motorola 68000 CPU. This followed 1983's Apple Lisa desktop workstation, which also had these features, but was too expensive and sold poorly.

The Macintosh was originally the brainchild of Jeff Raskin, who envisaged a much cheaper machine, but was taken over by Steve Jobs after being forced out of the Lisa team.

The Mac's operating system, System 1, was a cut-down version of the Lisa's desktop. Both took design elements from Xerox workstations (the first machines

Specifications

CPU: Motorola 68000 @ 7.83 Mhz **RAM:** 128 - 512 KB **Graphics:** Black-and-white @ 320x256
OS: System 1 - System 7 **Storage:** 3.5-in floppy, 400 KB - 1.44 MB, plus hard disk upgrades
Released: January 1984 **Production:** 1984 - 1992

to use a graphical desktop) in exchange for Xerox owning Apple shares.

The Macintosh was a near opposite to Apple's main seller, Steve Wozniak's Apple II. Where the Apple II valued openness and functionality, the Macintosh was extremely locked down and valued form, packing the entire system into a small carry-box with an integrated 9-inch monitor. Surprisingly,

the Macintosh was black and white, while the older Apple II was colour.

The Mac was an exercise in minimalism: the mouse had only a single button, and there were no arrow keys or function keys on the original keyboard. Apple wanted to encourage customers to use the mouse, and for developers to design applications around the desktop.

Standard units shipped with a single 400K 3.5-inch floppy drive and no internal storage. This resulted in a lot of disk swapping, but external hard drives and floppy drives were available for the impatient.

Despite its multi-window interface, the Macintosh was originally a single-tasking machine, though this changed with the introduction of Switcher in 1985, and 1987's System 5 OS came with multitasking out of the box.

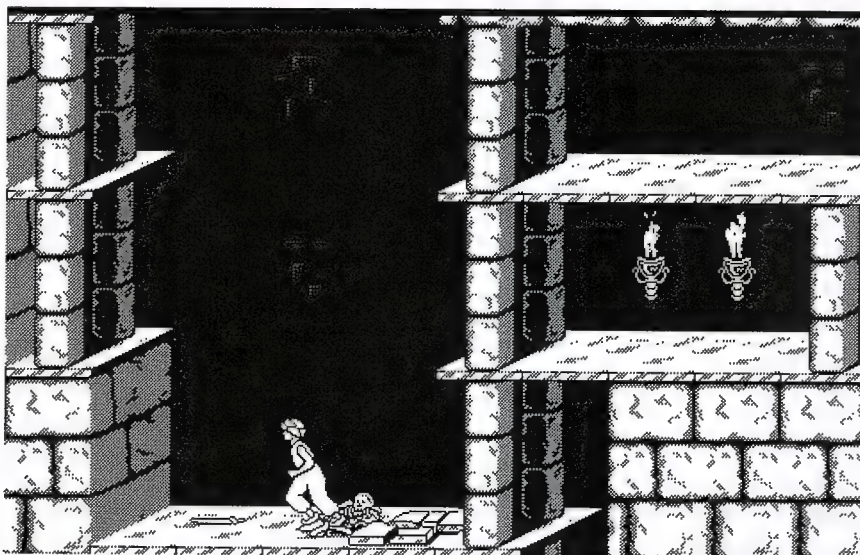
Software

Macintosh gaming had a large emphasis on the mouse. Many of these games are quite shallow, but there are some standout titles, like *Shufflepuck Café* (1988) and *Pararena* (1990), and strategy games benefited greatly from this new mouse input.

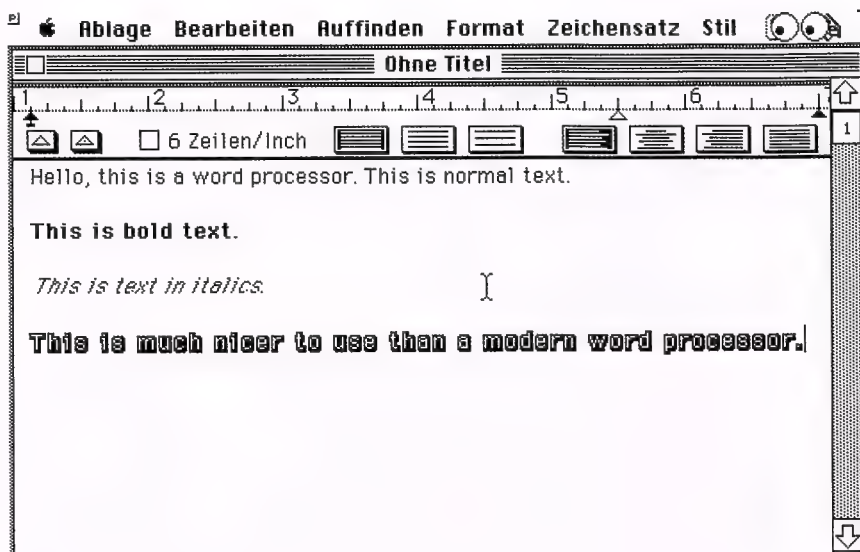
Trivial mouse games aside, early Macintosh gaming is an interesting experience. Eighties gaming was obsessed with colour, but using colour



You'll need this
 A copy of Mini vMac
 plus working system
 ROM and OS image.
 See the emulation section
 for further details.
[www.gryphel.com/c/
 minivmac/download.
 html](http://www.gryphel.com/c/minivmac/download.html)



Although late to the party, 1992's *Prince of Persia* showed how much further old machines could be pushed if only more developers were willing to try monochrome gaming.



If you've ever had a migraine just looking at Microsoft Word or LibreOffice, MacWrite offers you clean and simple serenity instead.

The Mac was an exercise in minimalism: the mouse had only a single button, and there were no arrow keys or function keys on the original keyboard. Apple wanted to encourage customers to use the mouse, and for developers to design applications around the desktop.

requires more RAM. Original Macintosh games were restricted to black and white, which allowed higher resolution gaming that was often much sharper and more detailed than other platforms of the time.

Dark Castle (1986) and *Prince of Persia* (1992) are two examples that feel very different, and arguably better, than rival systems' colourised equivalents.

But it's really in desktop applications where the Macintosh shines. Macintosh software is simple and elegant. Try something like MacWrite and it is much simpler, quieter, and more intuitive than today's bloated word processors. The original Adobe Photoshop is a joyful thing, and MacPaint makes a mockery of Microsoft Paint. If only it were colour.

Legacy

Year by year, the original Mac underwent many evolutionary changes.

The Macintosh 512K (launched in September 1984) quadrupled the system RAM. The Macintosh Plus (January 1986) and SE (March 1987) models added 1MB-4MB of RAM, and space for an internal hard drive or second floppy drive. 1989's SE/30 came with a high-density floppy and RAM expansion up to 128MB. Finally, the stripped-back Macintosh Classic sold from 1990 to 1992 as a budget machine.

It's difficult to find sales numbers for

the original Macintosh, but though initial sales were stronger than expected, those numbers soon decreased and it took until 1987 to sell a million units.

The original Macintosh enjoyed a production run from 1984 to 1992. It was eventually overtaken by its successor, 1987's Macintosh II series, featuring colour graphics and a 32-bit CPU.

Emulation

Initially, we found Macintosh emulation quite difficult, but we've streamlined the process the best we can. The two main emulators are Mini vMac and Basilisk II. Advanced users should try Basilisk II, but we found Mini vMac easier to get started and more stable, so we'll use that here.

Before emulating the Mac you need three things: a system ROM, an image of Macintosh OS, and a copy of StuffIt Expander – everything in Mac world uses Stuffit compression.

Legally, we can't recommend system ROMs or OS images unless you own the original products. But if you are in the clear, archive.org has a collection of Macintosh system ROMs. The MacPlus v2 and v3 ROMs are the only ones that work well with Mini vMac.

As for the OS, the Mini vMac website has links for System Software 6 boot disks, though annoyingly they are

double compressed, so you will have to extract the file twice until you're left with a file called "System Startup". Otherwise, if you want System 7, macintoshgarden.org has a software entry entitled "Mac OS 7.5.3 (for emulators)".

System 6 is simpler and boots a lot faster. System 7 is a lot more cluttered and slow to boot, but also more compatible. If anything doesn't work in System 6, try System 7.

Getting started

Once you have all the prerequisites, head to the Mini vMac website and open the Download page.

For anyone who is interested specifically in the first models, there is a 128K emulator variant, but for everyone else, click the link 'Download Standard Variations'.

Compressed files are provided for Windows, Linux, OS X, and other platforms. The Windows ZIP file contains a single executable file called Mini vMac.exe. The Linux package contains a single executable file that you may be able to run just by clicking on it. Otherwise, you can open a terminal and run it by entering:

```
$ ./Mini\ vMac
```

Once started, Mini vMac will give you an error message, warning you that it can't find a ROM image. Drag your chosen system ROM onto the Mini vMac window, and if your ROM is recognised there will be a loud beep and a floppy disk icon. This is a normal Macintosh screen – it wants a system boot disk. Click and drag your OS image onto the window and, all being well, your OS should boot.

Once your OS has loaded, you can explore disk images simply by dragging them onto the Mini vMac window, and if the image mounts successfully, a disk icon will appear on the desktop. If Mac OS says the disk image isn't readable, click Eject. Do not click Initialise – you may wipe out the image file!

Mini vMac has strange default settings and weird controls. The emulator is controlled by holding down Ctrl then pressing another key.

Firstly, Mini vMac runs at 8x speed by default. To change the speed, press Ctrl-S, which will bring up a speed menu, while keeping Ctrl held down, then press Z. The emulator runs in a small window by default, press Ctrl-M to make the window bigger. To make the window fullscreen, press Ctrl-F.

Be aware that you will make changes to your OS image, and it doesn't like being shut down badly. To shut it down properly, open the Special menu from the top menu bar and choose Shut Down, after which you can safely close the window. ■



MORE FIRST-PERSON PLAYSTATION EXCLUSIVES COMING TO PC

The two most recent Uncharted games are coming in 2022.

Console exclusives are fast becoming a thing of the past, with more and more first-party Sony games coming to PC. Following the release of *Days Gone* and *Horizon: Zero Dawn* on Steam, the company has confirmed the *Uncharted: Legacy of Thieves* collection is coming, which bundles *Uncharted 4* with its standalone expansion *The Lost Legacy*.

The port will be handled by Iron Galaxy Studios, which has done similar work on titles like *Diablo 3*, *Overwatch* and *Crash Bandicoot N. Sane Trilogy*, among others. The collection is releasing some time in "early 2022," when it'll hit PS5 as well.

While Microsoft has all but given up on console exclusives, opting to release all of its first-party titles on PC on day one, Sony is far less inclined to do so. As for Nintendo, well, don't hold your breath.

A NEW BROTHERS IN ARMS GAME IS IN DEVELOPMENT

Gearbox CEO quietly dropped the news months ago.

In an interview with Insomniac Games CEO Ted Price for the *AIAS Game Maker's Notebook* podcast, Gearbox CEO Randy Pitchford has confirmed the studio is working on a new *Brothers in Arms* game. The podcast was originally published in April but only recently uploaded to YouTube, where the wider public caught wind of it.

The *Brothers in Arms* project comes up during a discussion of Gearbox's *Aliens: Colonial Marines*. Pitchford explains how both Fox and Sega were so eager to share news of the project that both parties announced the game before any contract had been signed. "The second you hear Gearbox and *Aliens* and Unreal Engine, everybody already decided the game in their head," Pitchford said.

Price notes how unusual that early announcement was and Pitchford agrees, pointing out that Gearbox waited until *Borderlands 3* was late in development before announcing it. "I didn't even announce *Borderlands 3* until it was in beta," Pitchford said. "It sucks because I know there's a lot of people – we're working on another *Brothers in Arms* game – but I'm not saying shit until we have it. We have fans that really love that [series], but they're just going to have to suffer."



Details emerge on next year's inevitable Call of Duty

It's a return to the *Modern Warfare* sub-series.

Rain, hail or pandemic, 2022 will get its customary *Call of Duty* release, and according to leaks it'll be a return to the *Modern Warfare* series. *Call of Duty: Modern Warfare 2* (not to be confused with the other *Modern Warfare 2*, released in 2009) is a direct follow-up to the 2019 instalment of *Modern Warfare* (not the 2007 original), and will "include a campaign involving US special forces fighting a covert war against Colombian

drug cartels," according to anonymous sources speaking to the VGC.

None of this is surprising: Activision has its *Call of Duty* studios working on triennial release rosters, meaning 2022 will be Infinity Ward's turn – custodians of the *Modern Warfare* series. In the meantime, *Call of Duty: Vanguard* releases in November, so don't expect to hear much about *Modern Warfare 2* until mid next year.

More big 2021 games delayed

Two highly anticipated blockbusters have been pushed into early 2022.

Dying Light 2 and *Total War: Warhammer 3* have both been delayed into 2022.

While neither Techland (*Dying Light 2*) or Creative Assembly (*Total War*) have blamed the pandemic, these delays follow a familiar pattern of big game releases missing release targets due to Covid-19.

Dying Light 2's zombie parkour RPG needs another couple of months to "polish and optimise" the game, writes Techland

CEO Pawel Marchewka, while Creative Assembly product guy Rob Bartholomew said that "the new date will make for a stronger release and the best first step into a new era for *Total War: Warhammer*."

These delays follow other 2021 games that have moved into 2022, including *Hogwarts Legacy*, *The Lord of the Rings: Gollum*, and the *Prince of Persia: Sands of Time* remake, among others.



How *Psychonauts 2* almost cut one of its most important elements

"We really wanted to get those back".

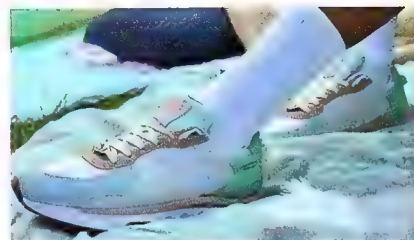
Double Fine boss Tim Schafer has made no secret about the fact that *Psychonauts 2* would not have had boss fights if his formerly independent company had not become part of Xbox in 2019. In an interview with G4 on YouTube, Schafer explained how the studio initially made the decision to cut each stage's boss battles to make up for being behind schedule and its then-publisher running into some financial troubles.

"And then, in talking to Microsoft, their question was, 'What would the

game be like if you weren't as constrained by resources?' And I was like, 'Oh, I'd put those boss fights back in,' Schafer explained. "It's so easy to cut boss fights, because they're kind of separate from the level, the level's complete without them.

"But not a *Psychonauts* level, because they often represent the big thing going on in that person's mind. You've gotta show it and then help the host of the mind fight it, overcome it or change the power balance."

In an interview with G4 on YouTube, Schafer explained how the studio initially made the decision to cut each stage's boss battles to make up for being behind schedule and its then-publisher running into some financial troubles.



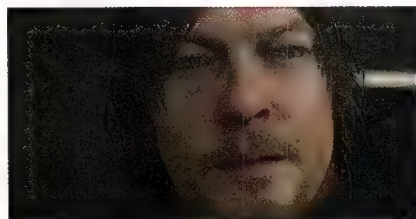
THESE FIRE *ANIMAL CROSSING* PUMA SNEAKERS ARE RELEASING NEXT MONTH

You'd look even cooler than K.K. Slider in these pastel kicks.

These *Animal Crossing: New Horizons*-themed Puma sneakers are cooler than they have any right to be, and they're launching on Saturday, September 18 as part of a collaboration between Nintendo and the German apparel company.

Every once in a while, a piece of video game apparel ascends beyond its status as such and into Cool Cat territory. There are a few different tiers of video game clothes before you reach that level: there's the stiff, boxy N64 t-shirts from Walmart whose logos peel off after one go at the laundromat, then there's the slightly more stylish retro-themed stuff you might find at places like Target, and finally, you've got truly high-quality, good-looking video game merch from specialty stores.

As revealed in a first look from SneakerFreaker, these *Animal Crossing* Puma sneakers are in another category altogether, right alongside the *Super Mario Bros.* x Levi's collaboration from last year. ■



DEATH STRANDING 2 IS "IN NEGOTIATIONS", SAYS NORMAN REEDUS

It looks like a *Death Stranding* sequel may be on the way. While we've yet to get official confirmation from creator Hideo Kojima nor Sony itself, *Death Stranding* lead character Norman Reedus recently told journalists at a *The Walking Dead* roundtable that *Death Stranding 2* was "in negotiations" before finishing off with an enthusiastic: "yay!"



POKÉMON TV IS AVAILABLE NOW ON NINTENDO SWITCH

Pokémon TV was already available on smart TVs, mobiles, and tablets, but this is the first time we can download the new app on Nintendo Switch. "Fans have the opportunity to watch select episodes and seasons of *Pokémon the Series*, journeying with Ash and his friends from Kanto to Galar and everywhere in between!" The Pokémon Company explains.



15th
ANNIVERSARY



\$99.95 | PC, XB1, XBS/X, Linux, Mac | store.steampowered.com

Psychonauts 2

Jump for joy, sorrow, regrets, and more.

It's been 15 years since the original; time enough to forget how silly *Psychonauts* can be, and the startling places those jokes can take us. Of course, for the game's inhabitants, it's been but three days: wannabe Psychonaut Raz left Whispering Rock Psychic Summer Camp on a rescue mission – seen in VR adventure, *Rhombus of Ruin* – and we rejoin him in its aftermath. A video fills all that in, but first-hand experience is recommended given the juicy callbacks throughout.

And what a start: a *Mission Impossible*-style con to fool a villain inside his own mind, only for a dental fixation to infect the plan. With its heroes' power to enter and influence the psyche I always thought *Psychonauts* did the *Inception* thing long before *Inception*, and this ESPionage only hammers the similarity home. Of course, *Psychonauts* doesn't settle for a dreamscape as humdrum as a rotating hotel corridor. Here you're riding molars, zapping tooth fairies,

and descending gurgling throats. It slips down the gullet of this returning fan just as easily.

Fundamentally, not much has changed since 2005. OK, it has an eye-searing prettiness that comes from an extra 16 years of HD know-how. But under levels that are variously knitted, hand drawn, or printed on x-ray film you still sense familiar cogs. It's another throwback to the 3D mascot platformers of the late '90s. An explorable hub world siphons you into standalone levels, all festooned with enough collectibles to give even Banjo and Kazooie cold sweats.

Raz hops inside heads to unpick personal traumas that both infect and shape the mental landscapes. Picture *Mario 64*'s self-contained worlds, if Tiny-Huge Island was a metaphor for Wario's impotence. On one hand they serve up the comfort food of those older platformers. You Hoover up hundreds of imaginary figments and earmark hidey-holes to return



Top: Raz gets cel-shaded for his psychedelic music trip.

Above: Who needs floss when you've got telekinesis?

to with later upgrades. It's solid, standard stuff and will keep completionists happy for 20 hours. But levels are much more than obstacle courses to tidy up.

Every mind tells a story. And not in the hackneyed language of audio logs and ten foot-tall 'help me' graffiti. This is level design as exposition. For example, one man's familial alcoholism becomes a toxic swamp where his shame manifests as a riverbed of discarded gin bottles that you navigate before booze drowns them again. Another standout sees a bureaucrat's clinical hospital of a mind hijacked by a casino. Exploring pill-filled pachinko parlours is a visual spectacle and can be appreciated as that, but the metaphorical dimension is just as satisfying to decipher.

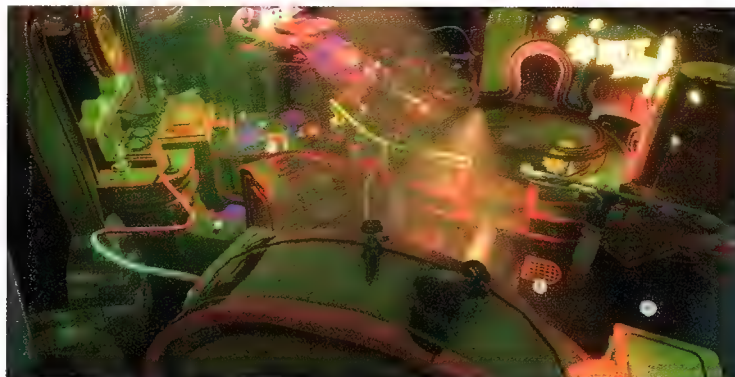
This is a mainstream videogame that deals sympathetically with the messy business of being human.

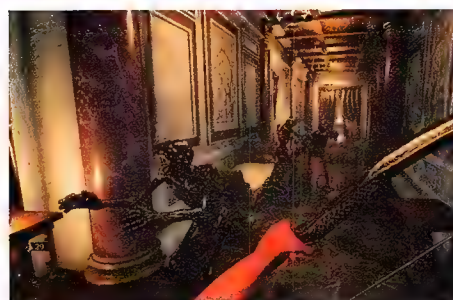
Improved platforming underpins a glorious return to one of gaming's most inventive and empathic universes.

Matt Castle

★★★★★

Many of the levels remind us of games like *Mario 64*.





\$35.95 | PC, XBS/X, PS4/5, Switch | forgottencitygame.com

The Forgotten City

A deep and enjoyable time loop mystery awaits.

The Forgotten City is a time loop game, one that makes excellent use of its magical reset button. You begin the adventure in the present day, stumbling into some ancient Roman ruins filled with golden statues before being whisked back in time through a portal. You arrive in the same Roman city, but now it's pristine and all those statues are living people. What happened to them? Why were they turned into gold?

The answers to those questions require lots of conversations with the citizens, who are almost without fail well-crafted characters, many with troubling secrets and interesting stories to tell. And the time loop is your best weapon, transforming you from a confused newcomer to a detective in a city full of suspects. It's a satisfying way to investigate, rewinding the clock to the start of the day to meet the same people and witness the same events, only with new eyes and new information.

As with all utopias, there's a dark catch to the reason the city feels so pleasant and peaceful. If anyone in the city commits a sin like stealing or killing, the ground rumbles and people

begin turning into gold statues. You must race back to the portal, which resets the day, giving you a chance to do things differently or maybe try out a completely new avenue of investigation.

The Forgotten City began as a mod for *Skyrim* before being recreated in the Unreal Engine. But its *Skyrim* roots are still apparent in the looks and animation of the characters and the dialogue system. Where it outdoes *Skyrim* is in those conversations, which are well-written and wonderfully performed.

The Forgotten City has four different endings, so there are plenty of reasons to spend extra time soaking up the finer details of this mysterious world and getting to know a collection of interesting characters even after you've solved it. If you have to relive a single day over and over again, this is a good one.

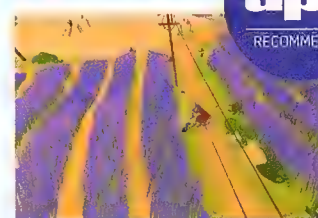
An intriguing mystery with some outstanding writing and performances.

Chris Livingston

★★★★★

Above left: There's a bit of combat, but this isn't *Skyrim*.

Above: You're not the only outsider visiting the city.



Free | PC | bit.ly/postbird

POSTBIRD IN PROVENCE

Having a jolly holiday with parcels.

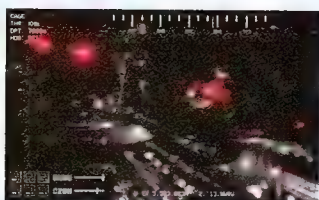
Here's a game about delivering mail around a picturesque French village. Despite being a bird – creatures that notably have wings – you deliver packages by bicycle, pootling through the narrow streets, skidding round corners and hurtling up ramps.

The best thing about *Postbird* is being in its endlessly sunny world. It's a vivid and painterly setting, and a joy to barrel around on your bike. But you can also hop off to grab a collectible, take part in a minigame, or just deliver the mail. There's some (very light) puzzling to the postal delivery, as apparently people in Provence don't write names on their packages. They instead put a little sticker that tells you something about the recipient – a sticker you have to match with the appropriate icon on the map. The (correct) recipients reward you with a few lines of funny dialogue.

There's incentive to stick around after the credits. There's a journal that fills in with every person you meet, every scenic viewpoint you snap, every collectible stamp you happen across in the town.

You'll curse the brief running time, but enjoy every minute in this cheery jaunt to France. **Tom Sykes**

★★★★★



Free | PC
olorfiction.itch.io/nodonus

NODOMUS

Opens a window to cosmic horror

Nodonus is going for an emotion that's awe, perhaps. And with a splodge of horror thrown in too. Rather than being somewhere from a first-person perspective, you're viewing the camera feeds of several drones, which are fixated on some possibly dreadful event. You can't move the drones, but you can zoom in and out, and turn the volume up and down.

My best guess is we're watching an alien entity fight a winning battle against humanity – we have a ringside seat as it attacks a factory and, possibly, a spaceship. The feeds are plagued by convincing video effects including flickering and constant static. But this obfuscation is what makes the game so compelling. If you're anything like me, you'll flick back and forth, back and forth between the camera feeds, trying to work out what it is you're seeing exactly. Zooming into the heart of the creature and being greeted by an ominous, rippling eye. Or finding yourself in an endless kaleidoscope of alien tendrils – possibly the creature's interior? *Nodonus* offers a window onto a frighteningly alien cosmic entity.

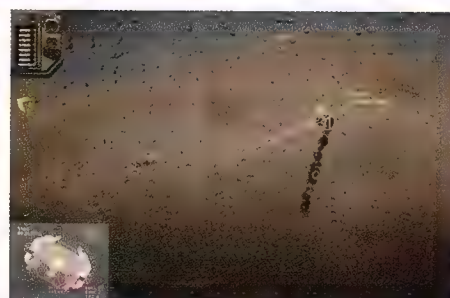
Confusing, but fascinating to witness.

Tom Sykes

★★★★☆



And with elements of the classic arcade *Lunar Lander*. And exactly as difficult, if not more so.



Above: Hope you like turning dials!
Above right: The environment detail is deliberately vague and mysterious.

\$42.95 | PC | koshutin.com

Highfleet

A frustrating mess and an impending cult hit.

The narrative of what you do in *HighFleet* sounds mesmerising. You negotiate with local warlords for alliances! Crack codes! Design new ships! Fly them around in intense combat, dodging bullets and launching missiles! All presented as their own little minigame or mechanic. It's also cleverly put together, with an interface that has you accessing the different parts of the game experience through the window of your flagship.

The core problem with *HighFleet* is that it's filled with minigames, and every minigame has frustrating obstacles. There's a whole system for launching stealth attacks, but I can barely even see how or why that matters.

Take combat as an example: you can have several ships, but you only actually control one at a time, in a twin-stick shooter-style piece of air combat. Combat looks and feels great. There's weather effects, including raindrops hitting the screen and darkening proceedings, wailing music to fit the vibe of the game, and booming gunshots. Controlling the ships is a constant tug-of-war with gravity, and reload times and ship

damage are just on the edge of difficult and frustrating.

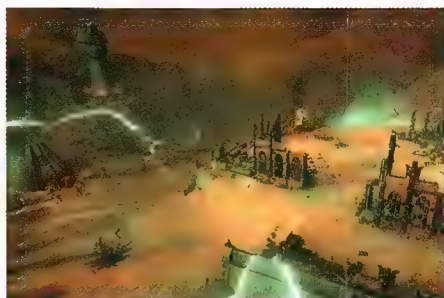
The strategic level of dealing with combat is off-putting as well. *HighFleet* provides a tutorial for how to launch ships away from your fleet to fight on their own, but either I lost most of the ones I sent off or I couldn't figure out how to call them back. And then there's the nightmare of landing ships in specific docking areas for slight repair advantages. In other words, I feel like I never had any idea whether I did well, well enough, or disastrously in any given combat. After every combat I have to decide, without strategic context, whether I need to try this again, which triggers frustration.

You might have the patience to puzzle out these systems. The clever interface and appealing style may bring you in and inspire you to figure out what each part of it means. There are lots of components that could appeal to the imaginary player in my head... but that player isn't me.

An appealing vision, but breaks down due to opaque systems and lack of difficulty options.

Rowan Kaiser

★★★★☆



\$56.95 | PC, XBI, PS4 | store.steampowered.com

Warhammer 40,000: Battlesector

Gives space marines some personality.

Warhammer 40,000: Battlesector is the latest attempt at putting some of the scale of tabletop 40K onto our screens. Which is to say, it's another turn-based tactics game about the Space Marines. But rather than generic armoured lummoxes it features one of the more interesting flavours: Blood Angels, the marines you get into if you watched too many horror movies when you were young.

Blood Angels suffer from Red Thirst, making them literally and figuratively bloodthirsty. In *Battlesector* this means they get more momentum points, which are normally earned for kills, the closer they are to their enemies – the enemies in this game being the dinobug alien Tyranids. When a unit gets 100 momentum they 'surge', getting a movement bonus and the option to trade in those points for an extra action or a single empowered use of an ability, which turn powerful attacks devastating.

It's tempting to play it safe, to go into overwatch on every turn. *Battlesector* drops into slow-motion during overwatch so you can see every shot go off and all the numbers flying out to emphasise it. But activating overwatch costs

valuable momentum, pushing you to instead commit to risky advances, getting your commander with the jump pack and thunder hammer leaping into hand-to-hand combat with some monster that gives birth to swarms of smaller enemies or vomits acid.

The Blood Angels' curse is double-pronged. As well as the Red Thirst there's the rarer Black Rage. Those it descends on spiral toward a berserk state that'll eventually kill them. They paint their armour black and form a separate unit, a Death Company that takes on dangerous missions in the hope they'll die doing something valiant.

Battlesector is best when it's about tactical play, whether it's encouraging you to make the most of its momentum rules, or to space units so they shoot from their most effective range, or to respond to venomthropes who fart poison into the ground by sending in tanks who don't give a damn about it.

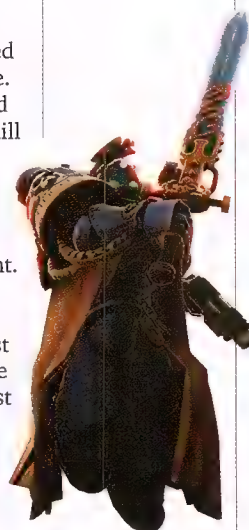
A characterful strategy game that could have gone a little further.

Jody Macgregor

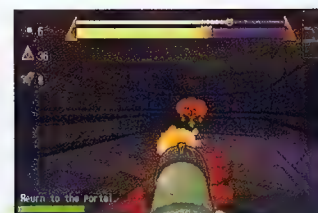
★★★★☆

Above left: An evocative alien world.

Above: A classic Warhammer battlefield layout.



A Space Marine Librarian ready to strike.



Free | PC

sonicrumpets.itch.io/killspira-tv

KILLSPIRACY TV

Shooting conspiracies to death.

Killspira TV feels pretty authentic to first-person shooters of the late '90s, even as it ditches their typical level design for procedural mazes. In each, your goal is to rescue a bunch of cultists – cowl-wearing types with televisions for heads – before hoofing it back to the entrance portal, if you can find it. I like the outlandish enemy and weapon designs, and the stages themed around graveyards, pyramids and other atmospheric settings. There are some impressive visual effects, including a low-poly mist I could stare at all day. But I spent much of the game lost, struggling between samey corridors. Cultists initially appear as twinkling guiding lights in the distance, but the game offers no such help when you're trying to stumble your way back.

There are some neat ideas here, including a playable menu screen that plunks you in the middle of the desert, and enemies that punish you for wasting time, by spawning in waves. Sadly, the shooting is disappointing, as the guns feel pretty puny to wield, with about as much aural oomph as water pistols.

Feels garish in an enjoyably '90s way. Tom Sykes

★★★★☆



GAME CHANGER

Close Combat V: Invasion Normandy

Twenty years later, this RTS is still just as innovative. Steven Messner kits up.

RELEASE October 2000 DEVELOPER Atomic Games PUBLISHER Mattel Interactive LINK bit.ly/2ViLhqN

During the frigid southern winters, the bush behind my house became a battlefield. Every night I'd meet my friends there and distribute our collection of toy guns and then we'd reenact the scenes we had seen in war movies. I vividly remember sitting in the snow, back against a tree, pretending I was pinned down by my friend who was now a German sniper. I was ten years old and blessed with an absurdly active imagination. Immersion was everything, so crawling for an hour through freezing slush just to get to safety was not out of the question.

This was just one of the ways my childlike fascination with war manifested itself. Between gory drawings of battlefields or watching what few WWII documentaries I was allowed to see, ten-year-old me was obsessed

with the thrill and glory of battle. Naturally, that troubled the hell out of my parents, who knew that war wasn't glamorous or cool. But despite them trying to tell me otherwise, that realisation only hit me the first time I booted up *Close Combat* on our family PC. This real-time strategy game was unlike any other I'd played, and it taught me that war is a lot more horrifying than my kid brain realised.

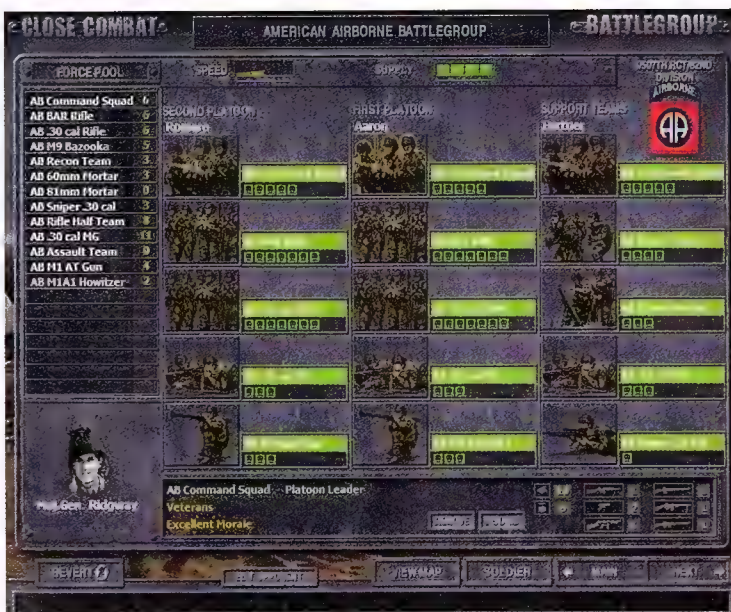
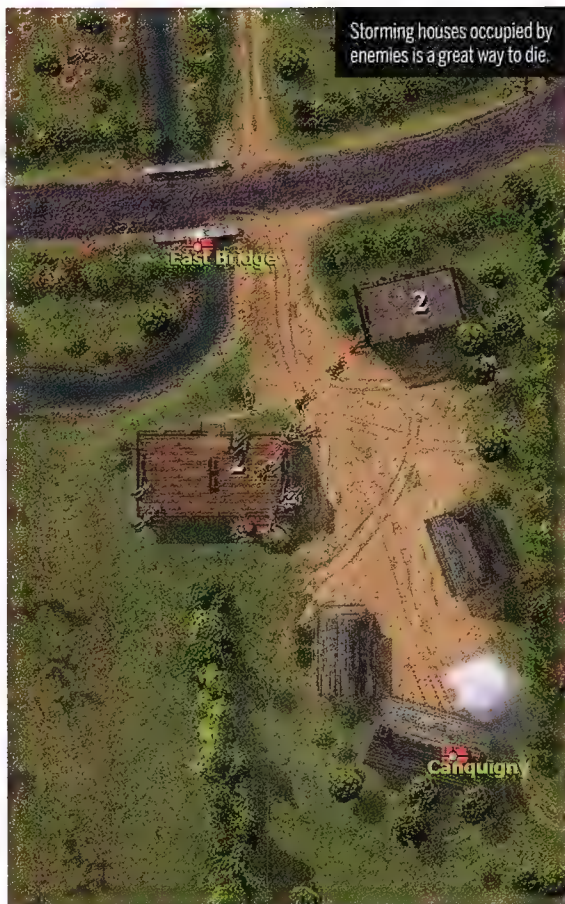
Reinstalling *Close Combat V* today, it's funny that I initially found its low-res battlefields so harrowing. But even if its graphics haven't aged well, there's still something unique and innovative about one of PC gaming's forgotten real-time strategy games.

Into the breach

Unlike most strategy games of the late '90s and early '00s, *Close*

Combat goes to great lengths to simulate WWII-era combat. There are no bases to build or resources to harvest, just dozens of platoons to manage as they slowly crawl across war-torn Europe, engaging in intense firefights. Years of *Command & Conquer* had taught me that my units were easily replaceable – clones endlessly churned out of a factory or barracks tucked into some corner of the map. So, like an idiot, my first move was to select my entire army and move them straight into the centre of the town we were fighting in to take one of the map's many capture points. No other RTS had required me to carefully position my units, so I was completely unprepared for *Close Combat*'s more simulated approach.

When German assault squadrons opened fire, I realised my mistake.



Amid sharp cracks of gunfire and horrifying screams, individual soldiers were cut down by the dozen. Those that survived quickly panicked and began to retreat while others just huddled on the spot – the UI readout telling me they're 'cowered' or 'pinned' – waiting for their turn to catch a bullet. The firing soon ceased and ten-year-old me stared blankly at

the bloody corpses of several dozen dead soldiers. I had sent them all into the meat grinder and those that survived were now too broken to fight.

This remains *Close Combat*'s best and most interesting feature. Units won't just blindly follow orders like in *Command & Conquer*, but will also consider the context of that order. Command a squad to charge

Above: You can customise platoons to try to counter enemy formations.

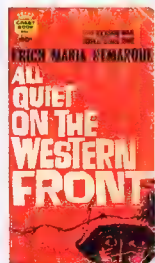
a fortified enemy position and they'll probably just tell you to get stuffed and sit right where they are, bursting with morale. Or if I order a squad to bail out of a house currently being shelled, there's a good chance some soldiers might be too shell-shocked to follow their comrades. Squads can even become separated in these situations, further adding to the realism and chaos of war.

All this depth was mind-blowing to ten-year-old me, and today it still feels remarkably innovative. Instead of health being a binary state between alive and dead, my squadrons feel like they are made of real people. People who can become scared and flee combat, or can become wounded and spend the rest of the battle squirming in a pool of their own blood among deceased comrades. That the game gives each soldier a name helps sell that these are more than resources to be expended in pursuit of conquest, and helps me track the survival of individual soldiers across a campaign.

It's a small (and somewhat morbid) touch, but I also love that corpses remain on the battlefield. A lot of RTSes from that era despawn bodies in order to keep the map

WAR STORIES

Novels that tell a soldier's perspective of war



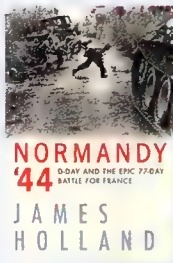
ALL QUIET ON THE WESTERN FRONT
ERICH MARIA REMARQUE

A haunting fictional account of a German soldier fighting in WWI. It paints a picture of how war dehumanises people.



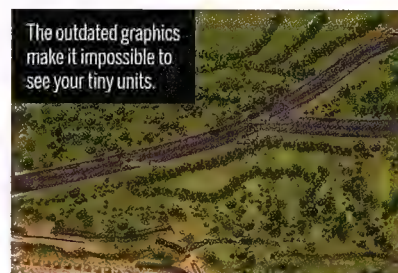
THE LONGEST DAY
CORNELIUS RYAN

Based on thousands of interviews and featuring 383 different personal testimonies, covering everything soldiers, officers, and civilians.



NORMANDY '44
JAMES HOLLAND

Covering the 77-day battle for France, this novel draws on first-hand accounts and focuses on the intense human story at the centre of Operation Market Garden.



readable, but that makes battles feel ephemeral. In *Close Combat V*, however, the story of iconic battles like Carentan is written by the clumps of dead soldiers that choke the streets after a fight.

That said, *Close Combat V* doesn't feel nearly as provocative as it did to me as a kid, being the little war worshipper that I was. There's still a visceral feel to its violence, but it wasn't long until I started hearing the same few screams repeated as more soldiers died. And while I'm genuinely shocked that the game even runs on modern hardware—at 1440p no less (it is letterboxed,

however)—the graphics have definitely aged poorly. The static, pre-rendered maps do a great job of bringing to life the pastoral fields of Normandy, but individual units are too small and lack detail. It somewhat counters the intimacy afforded by *Close Combat V*'s deep simulation of individual soldiers.

Bridge too far

What surprised me about my return to *Close Combat V* is how stellar its moment-to-moment strategy still feels. Each battle is a race to control as many capture points on a map, but *Close Combat*

Above: Fights over contested areas rarely resolve in one turn.

V moves at a tense crawl. Units move slowly and carefully and have a high degree of autonomy when it comes to making their own decisions. My job is to give them general orders, like moving to a certain location or attacking a specific area, but soldiers will also make their own decisions in the heat of a firefight. They'll even scavenge weapons off of dead bodies if they run out of ammo (did I mention each soldier has their own ammo?).

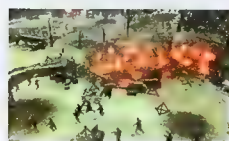
Close Combat V strikes a near-perfect balance between giving me enough tactical options, like being able to order a unit to toss smoke grenades to conceal an advance, while still making the soldiers feel like autonomous, thinking creatures I don't have absolute control over.

It's good that maps aren't all that big, because *Close Combat V* is a battle of inches. Most of the time, my eighteen squads (divided into three platoons), are crawling in the dirt trying to avoid enemy fire. Though it's technically a 2D game, *Close Combat V*'s simulation treats maps as if they are 3D environments with different elevation changes.

This can sometimes be

WAR GAMES

The best WWII-era strategy games



COMPANY OF HEROES 2
Get the *Ardennes Assault* DLC, which includes a dynamic turn-based campaign, and this becomes one of the most explosive and deep WWII real-time strategy games.



HEARTS OF IRON 4
An enormously deep wargame that lets you rewrite history and play as practically any country involved in WWII. *Hearts of Iron 4* is grand strategy at its best.



STEEL DIVISION: NORMANDY 44
Real-time battles with scope and a ton of options make this one heck of a hybrid between real-time strategy and traditional war games.

Nothing chews through infantry quite like a flamethrower.



Hightower	LEADER	HEALTHY
RELOADING	AP	380 rnds.
Ericson	ASSIST. LDR.	HEALTHY
CAN'T SEE	AP	135 rnds.
Duvall	SOLDIER	HEALTHY
FIRING AT AREA	AP	95 rnds.
Hinkley	SOLDIER	HEALTHY
RELOADING	HE	5 rnds.
Willcox	SOLDIER	HEALTHY
FIRING AT AREA	SP	8 rnds.
Darrin	SOLDIER	HEALTHY
RELOADING	AP	380 rnds.
Collins	SOLDIER	HEALTHY
RELOADING	AP	72 rnds.

frustrating because it can be hard to tell when the terrain might block a squad's line of sight. Trees, buildings and ditches are obvious, but more than once a flank was foiled because I didn't realise the enemy squads were protected by a slight hill. But I also appreciate how much it emphasises the need for careful positioning and proper infantry tactics.

I just wish there was a way to tell when squads were protected by cover or not. Natural obstacles like trees, bushes, and even downed planes can all be used as protection, but it's never quite clear if my units are properly concealed from incoming fire. I really wish there was a simple indicator, like the one in *Company of Heroes*, to show how safe my units are.

All the cover in the world can't protect you from a German Panzer or a mortar, though. Again, it's wild to see how deep *Close Combat V*'s simulation goes with these units. Tanks, for example, are crewed by soldiers that each have individual roles to fill and also have several stages of disrepair. Treads can be busted, leaving a tank immobile, or the main gun can be disabled by incoming anti-tank fire. If the tank is destroyed outright, its crew will

Close Combat V doesn't feel nearly as provocative as it did to me as a kid, being the little war worshipper that I was. There's still a visceral feel to its violence, but it wasn't long until I started hearing the same few screams repeated as more soldiers died.

flee and take up arms as regular foot soldiers.

In an individual battle, all these elements feed into enthralling conflicts as platoons fight viciously over every bombed-out house or fallow field. But *Close Combat V* really shines when you jump into one of its Grand Campaigns, which let you simulate a full-scale invasion of Normandy over the course of several weeks.

The long war

Echoing amazing sandbox campaigns like *Dawn of War: Dark Crusade*, Grand Campaigns dice Normandy up into two dozen battlefields that you fight over each turn. Managing several armies, including their resupply lines and reinforcements, adds even more depth to each battle. I love that individual soldiers persist through each fight, which makes me feel even worse when I make a bad call and get a squad of battle-hardened

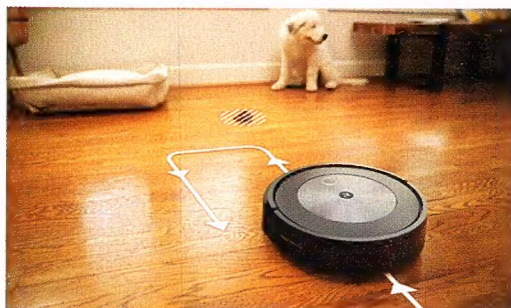
veterans slaughtered. There's also a lot of options to tweak in these campaigns. You can play as either German or American forces, but can also toggle different victory conditions and half a dozen other options that let you customise battles.

Playing *Close Combat V* today, though, just makes me sad that this series never seemed to keep its momentum. There are newer entries (and even overly-expensive remakes of *Close Combat V* and earlier games), but all of them seem to struggle in modernising the game or finding smart ways to expand the strategic options and challenge.

Even so, it's shocking just how enjoyable and playable *Close Combat V* is today. And though it's simulation of individual soldiers and their mental states isn't as revolutionary and eye-opening as it was to me as a kid, this is still a great World War II strategy game. ■

CHIP CHAT

JOEL BURGESS REPORTS ON THE UNUSUAL SIDE OF TECH NEWS



IROBOT TRAIN AI VAC TO AVOID POOMAGEDDONS

Roomba founder dares you to test its 'obstacle' avoidance.

Robot vacuums are generally a great addition to the modern household, but they do have a kryptonite that turns them from little automated cleaning Mogwais into disgustingly destructive Gremlins: dog poo. Even Roomba's creator commented 'we see this a lot' in 2016 when a particularly graphic event known as the poopocalypse began circling the web. So we're pretty stoked to see that iRobot has harnessed the true potential of AI by training its latest Roomba j7 to identify and avoid any doggy dynamite. iRobot founder and CEO Colin Angle even said in an interview "We've been working on it for a long time and we're guaranteeing that it works". The internet has been challenged.



LG IS MAKING A GIMONGOUS TV

It's also pretty expensive.

We can't imagine there's a massive market for televisions that can be seen from space, but if you've got a spare 4 meter by 7.2 meter wall in your house and you want to wrap it with 33 million pixels, then LG is the home cinema company for you. The 8K 325-inch DVLED screen is so big it makes more sense to measure the screen diagonal in feet (it's 27 foot). The 1200 nit brightness should be enough to compete with the sun and even though the 8K DVLED costs US\$1.7 million dollars, you'll probably want to set some additional money aside in the kitty to pay for the oversized electricity bill.

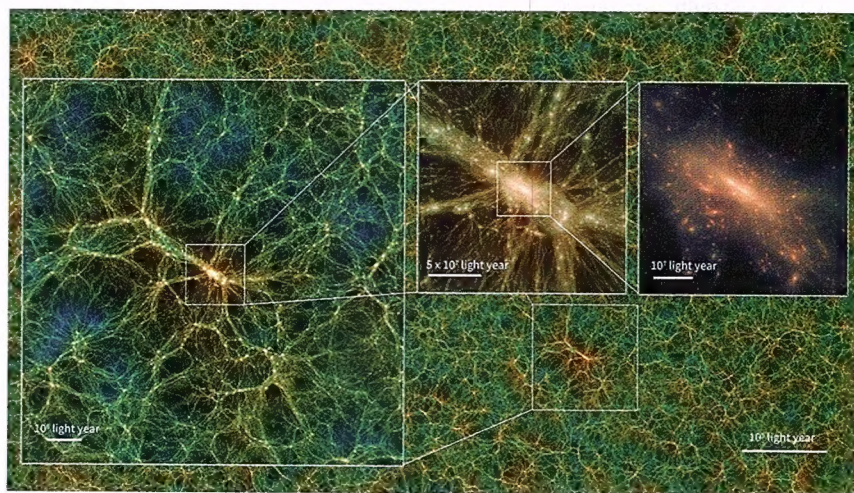


China bans video games

Well at least all the new ones.

In addition to introducing a new law that bans accounts held by minors from playing games for more than three hours per week, the *South China Morning Post* has reported that Chinese regulators are slowing new game approvals to curb gaming addiction in the country's adolescents. The publication cites multiple confidential sources that reported on a meeting in September

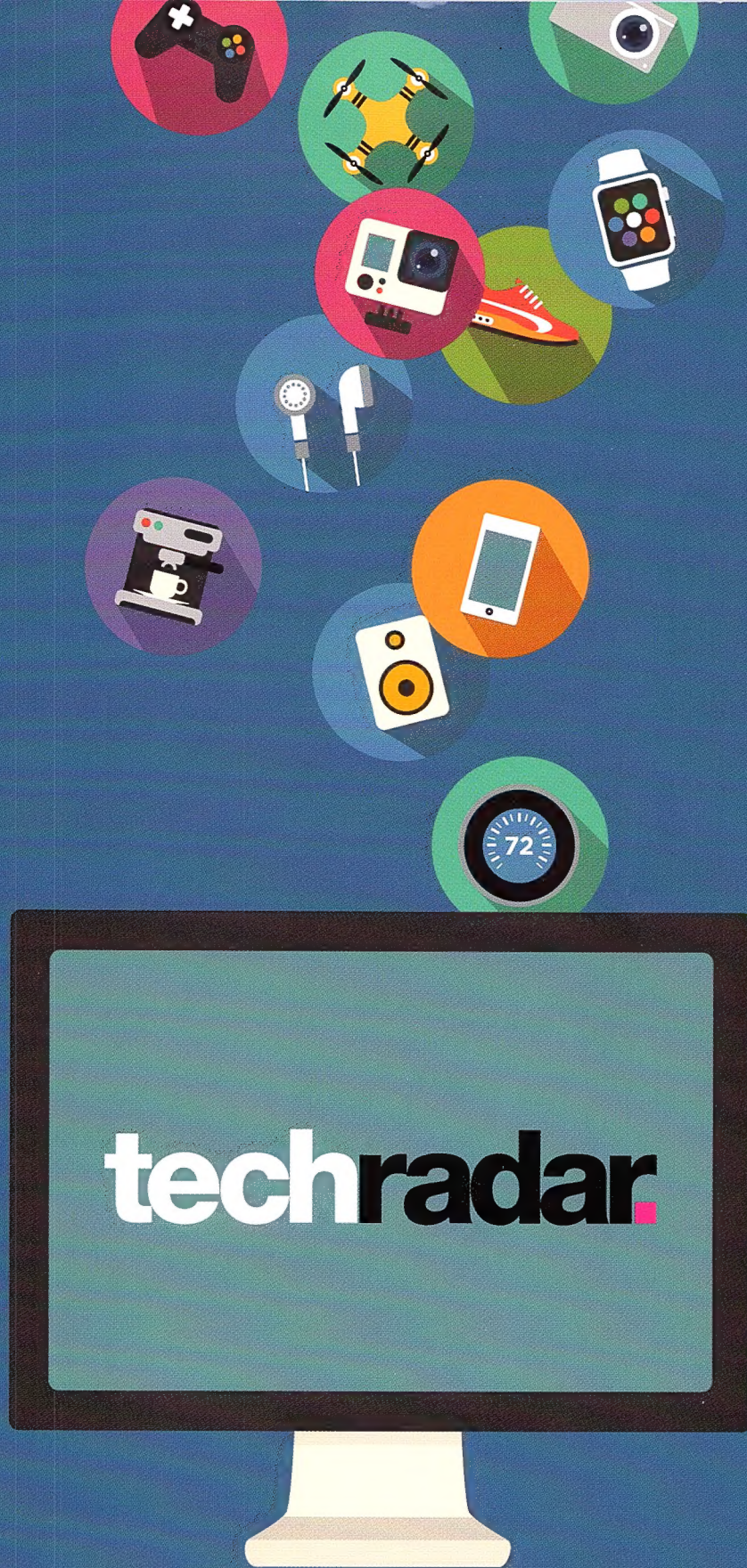
between the government's publicity department, the country's gaming watchdog and representatives from Tencent and NetEase. The conference apparently included discussion on how to best "cut the number of new games [and] reduce gaming addiction". In 2018 the country was subject to a nine month long freeze on new video game approvals.



YOU CAN NOW DOWNLOAD THE UNIVERSE FOR FREE

Researchers build the largest realistic universe model ever.

An international team of researchers have used the ATERUI II supercomputer at the National Astronomical Observatory of Japan to create the largest map of the universe to date and you can download it for free. Uchuu (Japanese for outer space) is a 2.1 trillion particle model of all the stars in deep space and with an overall diameter of 9.63 billion light-years. While the supercomputer has a peak performance of 3 Petaflops it still took it a year to process the 20 million supercomputer hours data in the model. The entire simulation is available for free in compressed form for anyone to download, you'll just need 100 free terabytes of space. ■



The source for tech buying advice

techradar.com

GIGABYTE™

intel®

15" / 17" AERO Creator Laptop Creativity Starts Here

Accelerate Production, Increase Inspiration.

The all-new AERO creator laptop has a performance upgrade with the 11th Gen Intel® Core™ H-series processor. The elegant and powerful design is paired with an unparalleled 4K HDR visual experience, bringing users a faster, smoother, and more immersive creative journey.



4K

SAMSUNG
AMOLED

VESA CERTIFIED
DisplayHDR™ 400

STARTING FROM

\$2,999

LEARN MORE OF AERO CREATOR LAPOTOP
<https://www.aorus.com/en-au/laptops/gaming/>



intel.
CORE
i7

intel.
CORE
i9